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MOTORSHIP

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AND FOR RECORDING INTERNATIONAL PROGRESS OF THE
MARINE INTERNAL-COMBUSTION-ENGINE

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The oil-engined motorship has arrived! It is such a pronounced economy that it was bound to come. Nothing could stop it! And all obstacles have been removed as fast as they arose. The law of progress has seen to that. Very strong prejudices stood in the way of steam. But, one after another they were swept aside and steam reigned triumphant for a century. Steam now has had its day! Its zenith has passed, and gradually but surely it is being superseded by the economical internal-combustion power. Steamships are becoming decadent. America, the most important oil-producing country, is to be the greatest motorship-owning nation. Let us all co-operate and assist to make that day soon.

January, 1920 Vol. 5 No. 1

EDITORIAL

THE ERROR OF FALSE ECONOMY

Too Sudden Retrenchment of Federal Expenditure Will Produce Business Chaos Throughout the Country

IT is the avowed intention of the new Congress to make retrenchment in Federal expenditures and enforce rigid economies throughout Government departments, including the mercantile shipping section. "Motorship" is not concerned with party politics, but necessarily must have a word to say when politics interfere with shipping progress. So drastic are the measures proposed to be taken by Congress that there is serious doubt of the Shipping Board receiving further appropriation for new ship construction, and the recent program, which calls for money for the construction of 32 economical motorships at a cost of fifty million dollars to assist in balancing our mercantile marine, is very likely to be turned down cold.

We appeal to the common sense of Members of Congress against such mistaken economy. If only to give private shipowners a lead it is vitally important that the Shipping Board construct the proposed Diesel-engined motorships. We have in service, or building, nearly two thousand uneconomical and oil-wasting Federal steamships, which are gradually being turned over to domestic shipping companies for operation or being sold to them.

As time passes American shipowners will find it virtually impossible to operate these ships against the keen competition of foreign motorships, and one after another the different overseas trade routes will be abandoned and the steamers laid up to rust or sold to other countries. Then au revoir to the great American merchant marine that we have blazoned forth to a cynical world. Then private owners will be too disappointed to risk further money in building motorships.

On the other hand, if there are about fifty large Federal-built motorships in the hands of shipowners running side-by-side with steamers, the owners or operators will be forced to realize the great advantages of Diesel-engine propulsion, and instead of laying up their steamers will convert them to motor power and also will build new oil-engined craft. Furthermore, the quantity of fuel-oil needed will be so moderate that "Mexican situations" will have no effect upon the fuel supply.

SHIPPING BOARD RE-INSTATES MORE CANCELED ORDERS FOR DIESEL ENGINES

IN re-instating the orders that have been canceled for eight of the 1,150 i.h.p. Diesel engines at the Skandia Pacific Oil Engine Co.'s plant, the Emergency Fleet Corporation officials have shown sagacity which seemed to be missing at Washington when instructions were issued by the Shipping Board for drastic wholesale cancellation of all Diesel-engine orders.

The Skandia Company, aided by European experience, have Americanized a well-known Dutch engine and have produced a machine which is a credit to any engineering country, so it is to be hoped that the Fleet Corporation will go a step further and by hook or crook provide hulls for these and the other motors on order, even if it is necessary to sell a certain additional quantity of fuel-wasting steam-machinery to other countries. The call of economy for ship operation demands this.

Originally twenty of these Skandia-Werkspoor marine sets were ordered, but after the Armistice eighteen were canceled, as were forty-eight of the fifty-two sets on order with the McIntosh & Seymour Corporation, of which orders for twenty-four motors were reinstated some months ago. This leaves a total of thirty-eight Diesel engines aggregating about 50,000 i.h.p. built or building for the Fleet Corporation, in addition to the pair of 2,150 i.h.p. Diesel engines purchased in Denmark. However, several of the McIntosh & Seymour engines have been sold to American oil companies.

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—AND, THEY SAY WE CAN'T BUILD SHIPS!

CAUSTIC remarks have been appearing in the British press regarding merchant ships built in the United States during the urgency of war conditions, and the suggestion implies that the majority of American vessels are poorly constructed, and partly for that reason our competition on the high-seas need not be taken seriously. That many of our vessels have been built in temporary shipyards by clergymen, bootblacks, and farm-hands, and that there was no intention to maintain all of these yards after the war, but that there would be a weeding-out, has not been taken into consideration. Nor has the fact been taken into consideration that most of our oldest established shipyards until now have been devoted almost entirely to naval work.

It is very likely that warship construction will be cut down in the near future, which means that our old yards and their new extensions will be devoted principally to cargo shipbuilding. As an example of what such shipyards will be able to do, let us quote the wonderful work accomplished at the Squantum plant of the Bethlehem Shipbuilding Company, which on October last attained its second anniversary. Up to that time this shipyard had constructed and delivered 22 destroyers each of 1,000 tons and over, launched seven more, and laid the keels of a further six. The last vessel to be delivered—of 1,215 tons displacement—was completed and delivered in 176 days. On her trials she attained a speed of 35 knots. This two years' output is a record that no British shipyard has ever equaled, and no one can dispute that American warships are not as well built as those of any navy. It is not difficult to imagine what such American shipyards as that at Squantum will be able to do in the way of merchant motorship construction when they take up the work in a serious manner.

A QUERY FOR THE SHIPPING BOARD

THE principal official reasons why the U. S. Shipping Board did not construct big Diesel-engined motorships during the war period were that the high-powered slow-speed Diesel-engine was more or less an experiment in the United States—"no one having built the same"—and that trained marine Diesel-engine operators were not available in sufficient quantities. At least, this is our understanding!

Under the circumstances, some remarks made in the third annual report of the Board issued on December 15th will be of particular interest. On page 50 the following remarks appear:

> "Early in the building program of the Emergency Fleet Corporation trouble had been experienced on new vessels fitted with steam turbine engines. In many cases this was attributable to the assignment of chief-engineers experienced in handling reciprocating-engines, but unfamiliar with the basic principles of geared-turbines. Engineers who understood turbines thoroughly were then scarce. This led the Recruiting Service to organize its turbine schools for chief-engineers. The principal manufacturers of these engines cooperated heartily with the Board. Instruction in the Recruiting Service's turbine classes is of a strictly practical character, with a proper proportion of class-room work, lectures, and blueprint study under expert instructors, to develop thoroughly the student's practical knowledge of turbines gained by previously handling them at sea or by actual work on progress in construction, and in the assembling shops, or both."

Furthermore, on pages 116-117 of the Report there is a statement regarding the Diesel-type oil-engine and its successful use in motorships, as follows:

> "As the Diesel-type of internal-combustion engine has demonstrated its practicability and reliability as well as an economic advantage of the highest order, it was thought advisable to make use of this type of engine in connection with the new vessels. In order to make an intelligent comparison, however, it was concluded that some of the vessels of the 10,000 deadweight-tons type, identical in every other respect, be fitted with quadruple-expansion engines and Scotch boilers, and the others with the Diesel-type internal-combustion engine."

In view of the Shipping Board's own comments, it would seem that, while they did not order Diesel engines "because it would have been a risky experiment during the urgent war period," they did not hesitate to order the type of machinery in large quantities, which is uneconomical and about which even less was known in this country, and for which the Shipping Board admits it had to establish a training-school. Also, although some Diesel engines were afterwards ordered, not a dozen Diesel-engine operators have been trained by the Shipping Board to this day, and we believe none are now undergoing training. Yet, some of the Diesel engines on order already have passed their tests. We consider the public is entitled to ask which officials were responsible for recommending that no Diesel-engines should be built for large cargo-ships while the country was at war, but that instead the Shipping Board should use the Nation's money for experimenting with the uneconomical geared turbined drive, which was more of an unknown quantity than the Diesel-engine. Because, despite the above remarks, only one large motorship has been ordered.

Is it any wonder that in his report for 1919 the Secretary of the Interior, Franklin K. Lane, stated:

> "We have ventured on a great shipbuilding program; on private ways and on Government ways ships are being built to go around the world—ships that are to burn oil under boilers and produce steam. * * * I submit that there should be justification shown for the construction of any oil-burning ship which does not use an engine of the Diesel type. To burn oil under a boiler and convert it into steam releases but 10 per cent of the thermal units in the oil, whereas, if the same fuel oil were used directly in the Diesel engine, 30 to 35 per cent of the power would be secured.
>
> "This Government might itself well undertake to develop an engine of this type for use on its ships. We simply cannot afford to preach economy in oil when we do not promote by every means the use of the internal-combustion engine for its consumption. *No other one thing that can be done by the Government, our industries, or the people, will save us as much oil from being wasted and thereby multiply the real production of the United States.* A nation that can educate 10,000 automobile mechanics in 60 days might indeed develop 1,000 Diesel engineers in a year. *The matter is of too great moment for delay.* It touches the interest of everyone."

Mr. Lane is to be warmly complimented on his frank and sound advice, which is to be hoped will be followed by Congress, by the United States Shipping Board, and by domestic shipowners. It is said that what is done cannot be undone. Nevertheless, it is not too late to change such vessels that are wasting our oil-fuel up their smoke-stacks into economical oil-burning Diesel motorships. The first cost will be high, but the resultant economy will wipe off the charges by the time lower ocean freight rates make rigid economy an absolute necessity for American merchant ships that are to keep on the seas in competition against the motorships of other nations.

LARGE DIESEL-DRIVEN WOODEN BULK-OIL CARRIER

Novel Type of Motor Barge for an American Oil Company

Now under construction at the National Ship Building Co.'s yard at Orange, Texas, is a large motor tank-barge of novel design and construction, to the order of the National Oil Company, Woolworth Building, New York. She is of wooden construction, and as carrying of oil in bulk has never been attempted before with so large a wooden ship, her advent will be watched with interest by other oil companies.

Her capacity will be about 35,000 barrels of oil, or approximately 5,000 tons on the following dimensions:

Length O. A.	314 ft.
Length B. P.	300 ft.
Breadth, Moulded	48 ft.
Depth, Moulded	34 ft.
Draught, maximum	27 ft.-28 ft.
Power	1,000 I.H.P.

Propulsion will be by a Diesel engine in conjunction with auxiliary sail, the vessel being equipped with three masts and schooner rig. The engine is a six-cylinder, four-cycle reversible type McIntosh & Seymour, having an output of 750 shaft H.P., or say 1,000 I.H.P. We presume a loaded speed of about 7 knots will be attained, which should be sufficient for a barge in sheltered waters.

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Americanizing an European Engine

First Details of the 1150 I.H.P. Skandia-Werkspoor Four-Cycle Marine-Diesel Engine for the U. S. Shipping Board Emergency Fleet Corporation

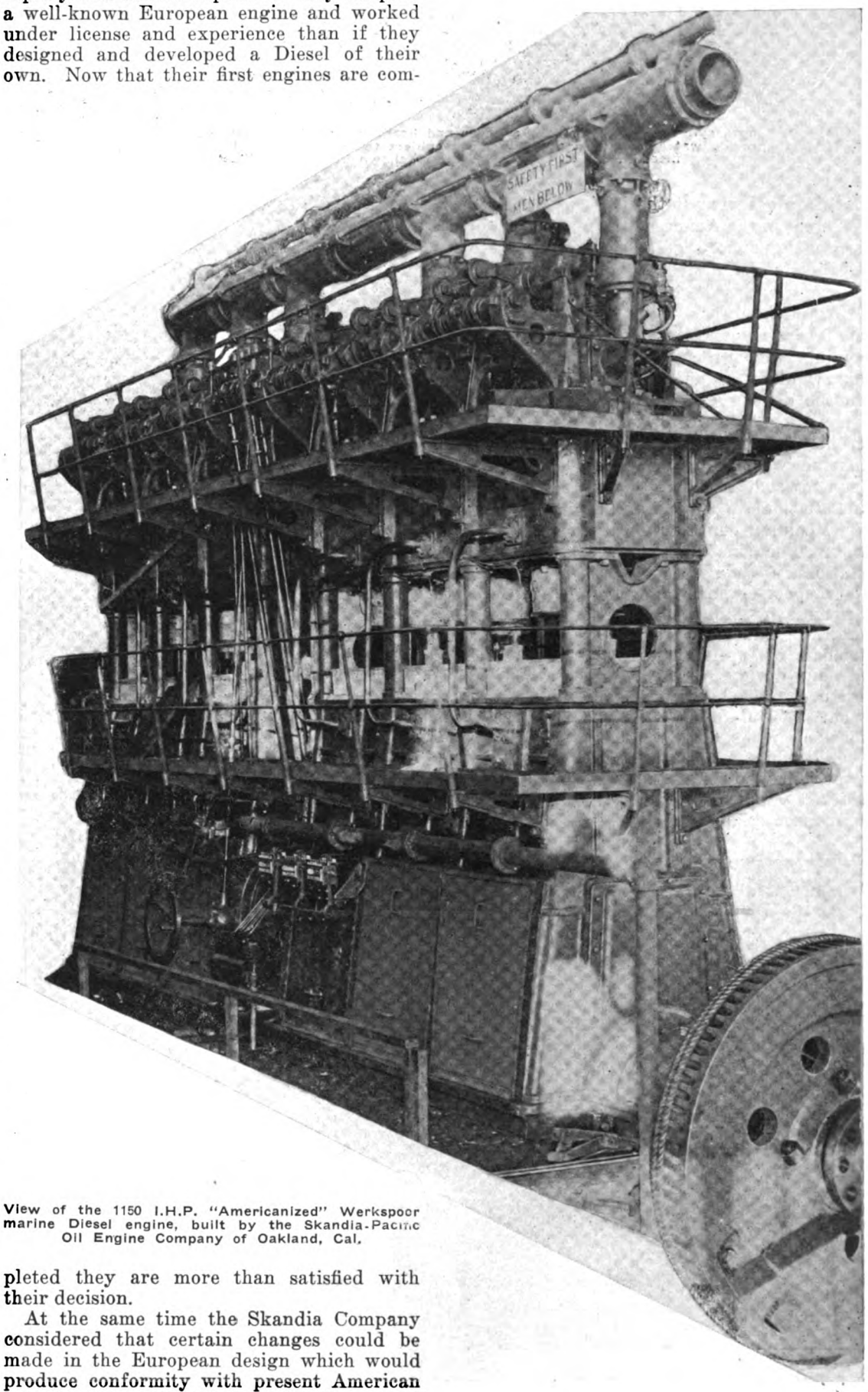
Those who read the article on the latest design of Werkspoor marine Diesel-engine as built in the parent works in Holland will be doubly interested in details of how this merchant-ship's power-unit has been developed in the United States in conformance with American ideas, shop-practices, and maritime-conditions. For, a twin-screw set is under construction for the Standard Oil Company as well as five 2300 I.H.P. twin-screw sets for the U. S. Shipping Board Emergency Fleet Corporation, the first pair of which are almost ready for tests. But, work at the Skandia-Pacific Oil Engine Company's Oakland plant has been suspended for some months owing to all their workmen being on strike, following the "stop-work" policy of the majority of the laboring element throughout the world. Except for this unfortunate delay, tests of the first set of Skandia-Werkspoor engines would have been made a considerable time ago.

Originally twenty of these engines were ordered by the Fleet Corporation, but on signing of the Armistice eighteen were canceled. However, an order for eight was recently reinstated, leaving ten motors under construction. The twenty engines, together with fifty-two McIntosh & Seymour units, were ordered for "submarine-evasion" steel ships of 5600 tons d.w.c. each, of special design. They were straight-line double-ended craft with no smoke-stacks and telescopic masts, the idea being that when camouflaged it would be extremely difficult for enemy submarines to ascertain their course. All structural parts of the steel hulls were to have been fabricated inland and erected on the Atlantic and Pacific coasts. In fact it was one of the best propositions contemplated by the Shipping Board during the entire war period, but much opposition was met internally, so a start was not made until just prior to cessation of hostilities, when there was no longer any necessity for this particular type of freighter, so contracts for the hulls were never placed.

Strong feeling against the economical Diesel oil-engine by steam-machinery supporters in the Fleet Corporation continued to manifest itself after the armistice so that funds were never diverted in order to build regular cargo-ship hulls for the Diesel engines. So today there are forty Federal-owned Diesel engines of approximately 37,000 shaft horse-power for which there are no hulls, excepting a few engines that have been sold to oil-companies for tankers. As the Shipping Board in its latest report states that there can be no disputing the reliability and high economy of the Diesel-engines, either strong representations should be made to Congress for money, or else other funds diverted for the purpose of providing hulls. Then the completed ships should be sold to domestic shipowning companies.

There can be no doubt that the Fleet Corporation were exceedingly wise in reinstating the canceled orders for these engines—in fact, if they erred it was on the "economy" side in not completing the entire 72 Diesel units, and so far as these propelling-sets are concerned the only error in judgment beside that just referred to is not having somehow-or-other arranged for hulls. We expect that officials of the corporation will be divided in their opinions regarding the particular view taken by "Motorship", but opinions cannot alter facts.

We can now turn a little attention to the Skandia-Werkspoor engines. The builders, the Skandia-Pacific Oil Engine Company of Oakland, California, when they first decided to extend their plant and add the building of Diesel-engines to the construction of Skandia surface-ignition oil-engines, considered that success could be attained more rapidly and at less expense if they adopted a well-known European engine and worked under license and experience than if they designed and developed a Diesel of their own. Now that their first engines are completed they are more than satisfied with their decision.



View of the 1150 I.H.P. "Americanized" Werkspoor marine Diesel engine, built by the Skandia-Pacific Oil Engine Company of Oakland, Cal.

At the same time the Skandia Company considered that certain changes could be made in the European design which would produce conformity with present American practice without interfering with the general and well-known characteristics of the original design which has given such excellent duty in many merchant ships, as is indicated by the letters and log-records from the owners of about a dozen Werkspoor-engined ships given at the end of this article. For instance, the Holland-built engine has the cylinder-beams carried on vertical steel-columns with diagonal steel bracing-rods, and the crosshead-guides are carried on heavy

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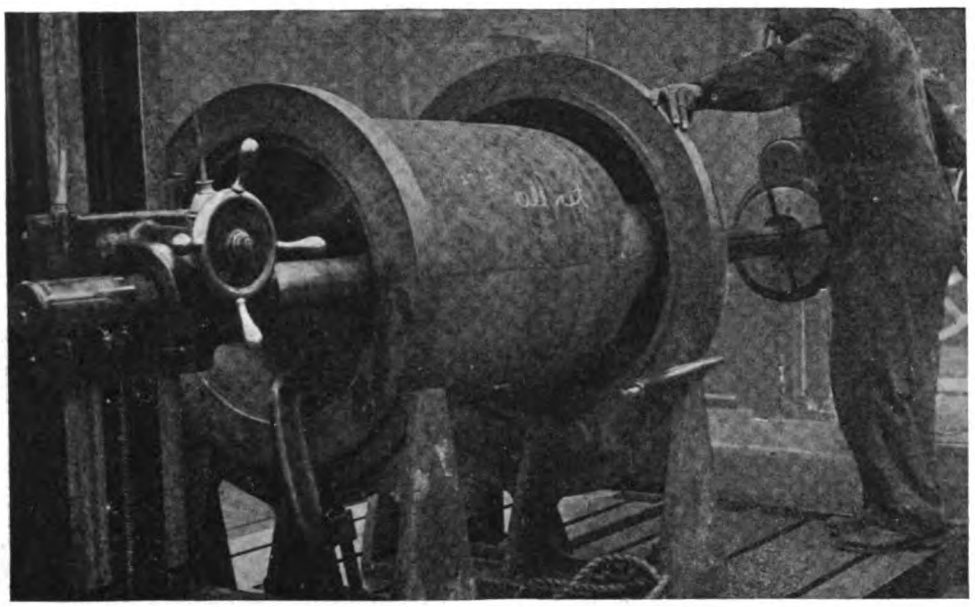


Boring a cylinder. Note how the cylinder and head are cast in one mushroom piece in order to provide water-cooling space at the part subject to the maximum heat. This cylinder is fitted in the tank (cylinder beam) shown in the next illustration.

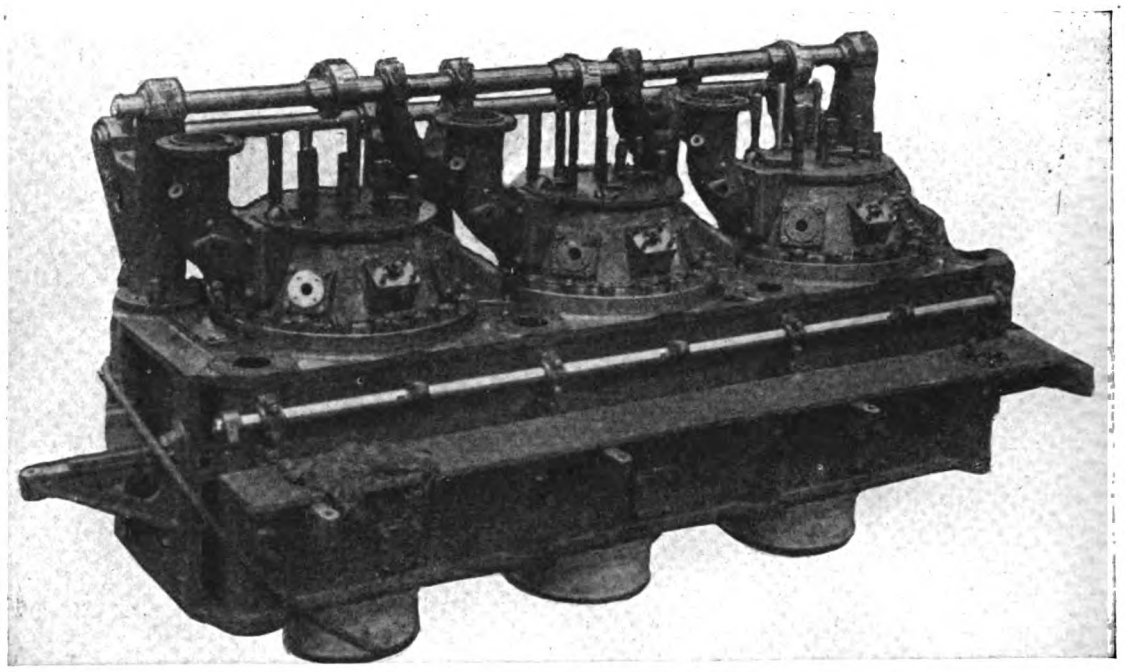
The following are the main dimensions of the 850 shaft H.P. (1150 Indicated H.P.) marine engine as built at the Oakland, California, plant:

Equivalent to Steam I.H.P.	1025 H.P.
Diesel Indicated H.P.	1150 H.P.
Shaft (Brake) H.P.	850 H.P.
Engine-Speed	140-135 R.P.M.
Weight, including flywheel, thrust-block, compressor, pumps, etc.	120 tons
Length (including above)	38′ 5″
Height (from center of crankshaft to top of cylinder-head)	15′ 3″
Overall Width	7′ 6″
Mean Indicated-Pressure	92 lbs. per sq. inch
Guaranteed Fuel-Consumption	0.41 lb. per shaft H.P. (0.33 lb. per I.H.P.)
Mechanical Efficiency	75%
Diameter of Crankshaft	12 9-16″
Diameter of Crankwebs	7.874″
Number of Working-Cylinders	6
Bore and Stroke	20.472″ by 35.433″
Piston-Speed	800 ft. per minute
Diameter of Piston Rod	5.118″

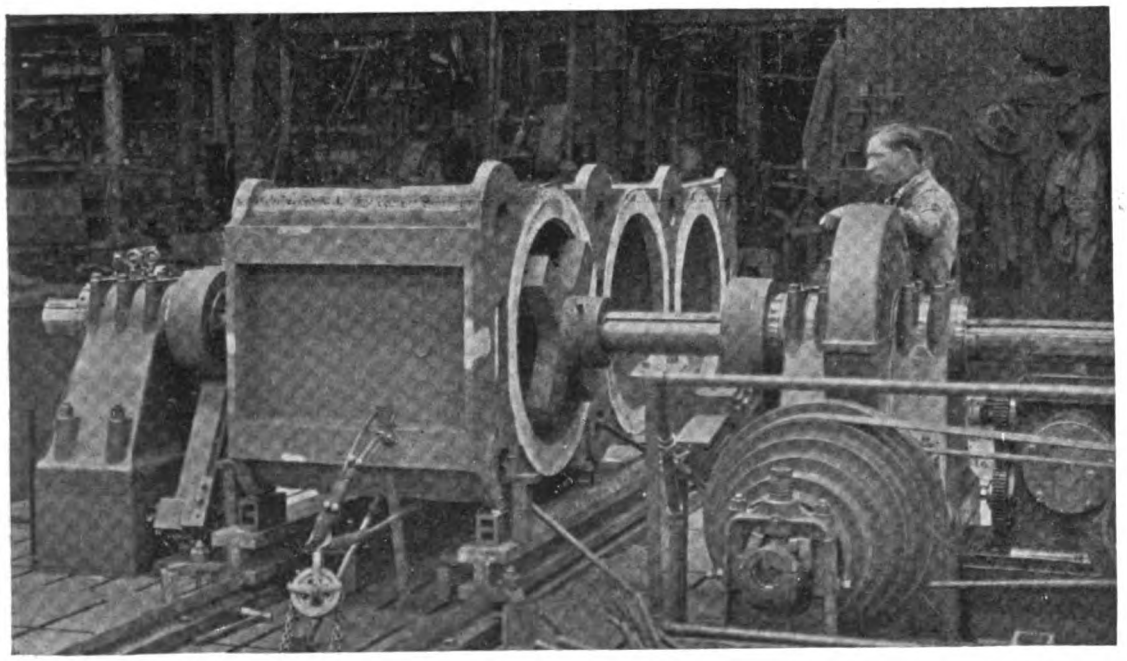
Incidently, we may mention that the 2000 shaft H.P. model (2750 I.H.P.) has a bore of 31½ in. by 53 in. stroke and turns at 90 R.P.M. This engine is for cargo-liners of 10,000 tons d.w.c. and 14 knots speed, giving 5,500 I.H.P. a twin-screw set. There also are 550 shaft H.P., 1050 shaft H.P. and 1500 shaft H.P. models.

cast-iron columns at the back of the engine. Whereas in the American engine the diagonal braces have been deleted and the vertical steel-columns carried through cast-iron columns on both sides of the engine.

These changes were made by the Skandia engineers in collaboration with four expert engineers from the parent factory in Amsterdam and with the engineers of the Diesel engine department of the U. S. Emergency Fleet Corporation, and the results are a credit to American engineering. While for marine work the engineers at Amsterdam lean toward their own design for cargo-ship installations, this combination cast-iron and steel column construction is to be found in their submarine-engine and in some of their stationary sets, also in the French-built Werkspoor-engine illustrated in the December issue of "Motorship". So, strictly speaking, the American licensees have made a transfer of application rather than produced a new design, except for certain minor features. Perhaps we should not repeat what a well-known engineer recently remarked, namely: "the design incorporates the benefits of all marine Diesel-engine experiences so far attained and might be considered a logical style for high-power in the four-cycle single-acting type."



Three cylinders in position in the "cylinder-beam", showing detachable extensions below the "beam", also the holes thro' which the steel columns pass. This "beam" is a cast-iron tank and is full of cooling sea-water. The temperature is not high enough to cause deposit.



Machining one section of the cylinder-beam of the Skandia-Werkspoor Diesel engine. This casting forms a tank of water into which are fitted the cylinders depicted in the upper illustration.

Referring to the dimensions of the Fleet Corporation engine, it will be seen that the engine, while a little longer than the Amsterdam production—due to the air-compressor being at the forward end, instead of being operated by rocking-levers off the crosshead—is still very compact and allows of an engine-room of 45 feet, giving ample room to walk around the engine. *This means a great gain of cubic cargo-capacity compared with a steamship of the same size*, especially if we take into account the absence of boiler-water tanks, and 'tween-deck bunkers.

Following the parent design the cylinders are arranged in two large cast-iron boxes or tanks, bolted together, which may be termed a "cylinder-beam", as in addition to holding a big supply of cooling sea-water they afford rigidity to the engine itself. The lower part of the cylinder projects through the underside of the cylinder-beam and has a detachable piece, permitting easy and rapid removal or inspection of the piston and piston-rings. This also is a well-known feature of the parent design so needs no further description.

Between the cylinder-beam and the cast-iron frames are cast-iron distance-pieces through which the steel columns run, allowing the entire engine from head to base being bolted rigidly together and so eliminating vibration and weaving, the steel columns running from the upper part of the cylinder-beam down to the bed-plate. Nevertheless, removal of the

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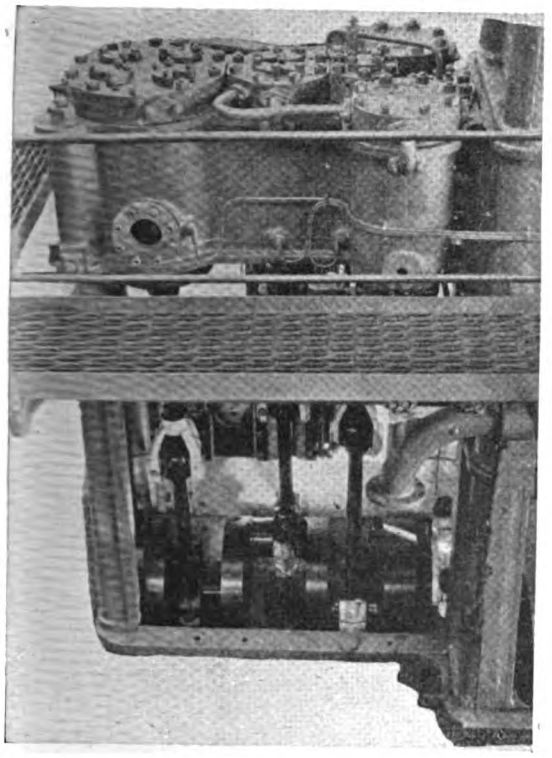


The air-compressor with its intercoolers. This is arranged at the forward end of the engine, and is noteworthy by reason of each stage being separately driven by its own crank, and that it is of crosshead and guide construction.

crank-shaft is an easy matter, as on rear side of the engine the cast-iron columns are made in two pieces, bolted together, and upon raising the steel columns the lower sections of the cast columns slide out, and the crankshaft can be lifted out. As there is no side strain on this two-piece column casting, it is a practical engineering job.

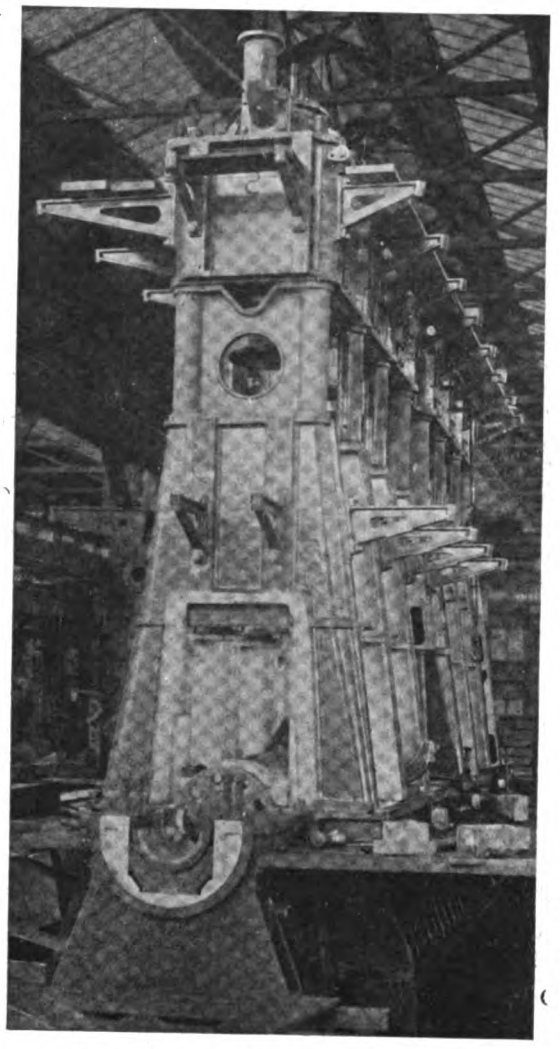
Between the cylinder-beam and the upper part of the cast-iron frames there is a cast-iron drip-tray running the engine's length for collecting all carbon or dirty oil from the cylinders, and all waste cooling-water, so that nothing can leak on to the bearings or into the crankpit. The piston-rod passes through simple stuffing-boxes in this tray, and which are not exposed to heat of any kind.

The lower halves of the main-bearings are set into saddles in the bed-plate, and the faces of the saddles are scraped until they fit, and the bearing-shells are scraped into the saddles. Adjustments for wear can be made by inserting the shims under the saddle. Single-shin guides have been adopted and are on the operating (front) side of the engine.

As the Werkspoor system of casting the cylinder-head in one piece with the cylinder has given such good results and freedom from cracks, it has been retained, because of the unusual cooling facilities afforded. There is no cylinder jacket in the general sense of the word, the cylinder itself being immersed in the tank of water. It is fitted with a light liner hydraulically pressed into position.

Details of the reversing-gear need not be discussed, as this is the same as now adopted with the parent engine and fully described and illustrated on pages 56 and 57 of our November issue. It will be remembered that there is only one camshaft and this does not move except to rotate continuously at half-engine speed, reversing being accomplished by turning the rocker-shaft 180 degrees. The valve-rockers are both eccentrically and diagonally mounted.

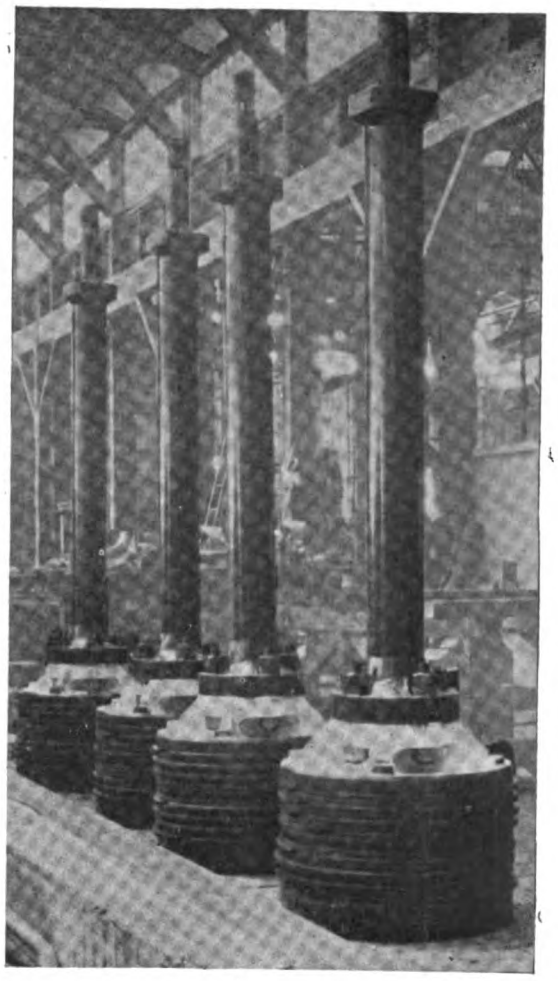
Much engineering interest will be taken in the compressor, as, while this follows the well-known Werkspoor practice of separately operated stages, they are not rocking-lever driven



Forward end of Skandia-Werkspoor engine showing framing, bed-plate and extension for air-compressor.

as is usual, but are driven off the forward part of the engine by an extension of the crankshaft. The lowest stage is furthest away from the engine, and each stage has a separate crank. The high-stage has a detachable liner, and the second stage is arranged between the high and low stages without liners. A compressor of this design was adopted with the Werkspoor submarine-engine, described in "Motorship" of April, 1917.

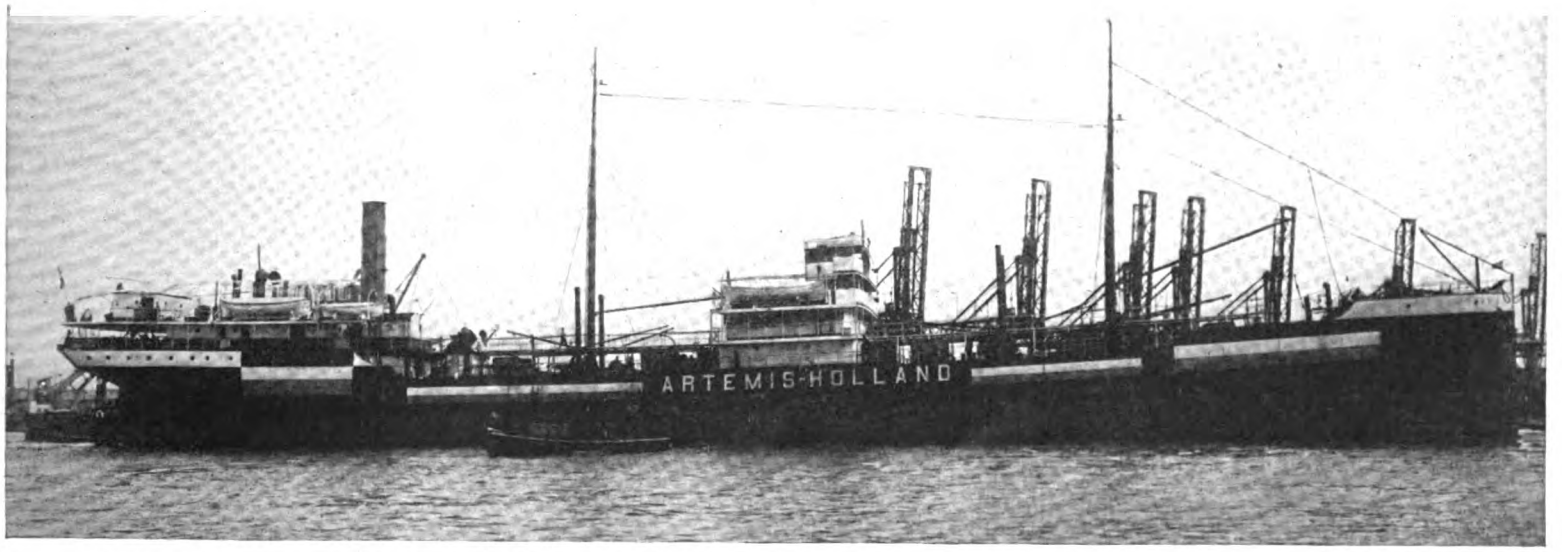
Because of the old "Emanuel Nobel" incident, unfounded rumors have been current that some of the Werkspoor engined-ships have not been very satisfactory, regardless of



Four Skandia-built 20½ in. diameter pistons, and their piston-rods.

the fact that the owners of this vessel are desirous of taking out the steam machinery and replacing the old Diesel-engines. Incidentally, it may be remarked that it was not the owners who removed the motors but the American operators, who installed steam-machinery made at their associated steam-engine-building plant, and who have frankly advised us they do not believe in the Diesel-engine.

Therefore in the interests of the entire American heavy-oil-engine industry and to prevent further spreading of erroneous impressions, we give herewith a letter written by the Anglo-Saxon Petroleum Company, St. Helen's Court, Gt. St. Helens, London, E. C. 3, England, who operate a dozen Werkspoor-Diesel engined ships. The letter is signed by Mr. C. Zulver, the Marine-Superintendent, and was recently addressed to Mr. H. S. Johannsen, 50 Church street, New York, the Eastern representative of the Skandia Co. It reads as follows:



The motorship "Artemis", whose 25 voyages are recorded on the next page. She is one of a fleet of 20 Diesel oil-engined motorships operated by the Anglo-Saxon Petroleum Co. of London, of which eleven have Werkspoor engines.

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Dear Sir:

"We have pleasure in handing you some particulars of the running of our motor vessels, which we trust you will find interesting. We might say we are in every respect satisfied with the results obtained.

"We should be glad to send you any further information which might promote the introduction of internal-combustion-engines for marine purposes."

2nd June, 1919.

(Signed) C. ZULVER,
Marine Superintendent.

[Here follow the particulars referred to—Editor.]

LOG OF M. S. "ARTEMIS" (25 Voyages)

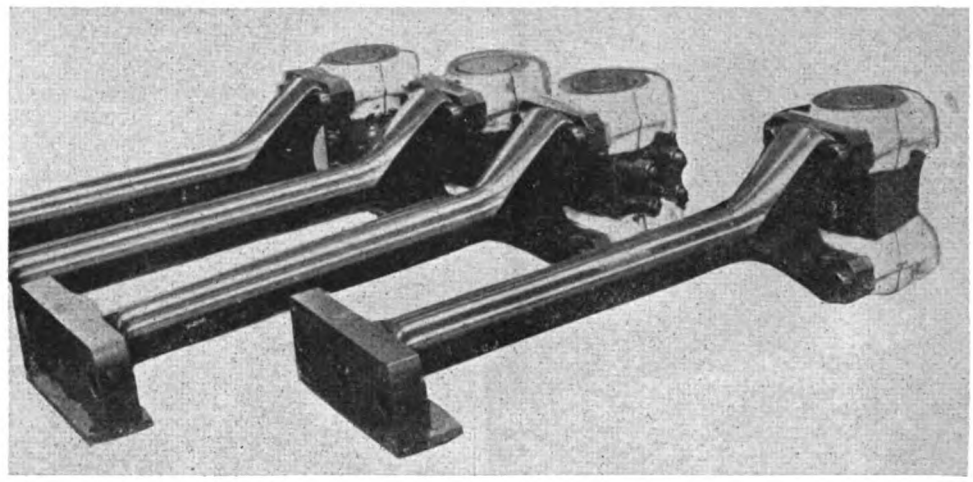
Operated by ANGLO-SAXON PETROLEUM CO.

Voyage	Nautical Miles	Hours	Average Speed Knots
1st	2359.5	263½	8.93
2nd	981	129½	7.56
3rd	2006.5	137½	8.44
4th	1111.5	129¼	8.6
5th	494.5	50½	9.77
6th	170	16½	10.3
7th	3144.5	288	10.92
8th	241	29½	8.17
9th	4958.5	472	10.5
10th	2131	210½	10.2
11th	2089.5	209¼	9.99
12th	1055	102	10.26
13th	1528	157½	9.69
14th	612	58½	10.46
15th	2554	297¾	8.58
16th	493	48	10.28
17th	2070	219¾	9.41
18th	2554	286¼	8.92
19th	508	53	9.58
20th	223	24	9.27
21st	1880.5	202	9.31
22nd	617	64¼	9.58
23rd	608	66½	9.1
24th	4618	525¼	8.79
25th	4960.5	539	9.2
Total	43968.5	4579¾	9.6

N. B.—Vessel was fully loaded practically all the time.

(Signed) C. ZULVER,
Marine Superintendent.

[Here follow details of a typical voyage lasting 26½ days during which there was one stop of the starboard engine lasting but a few minutes.—Editor]



Four of the connecting-rods for one of the Shipping Board's Skandia-Diesel engines.

Ship	Displacement.	Indicated Horse Power	Date Ordered.
Vulcanus	2050	650	Feb. 1910
Juno	4370	1600	April 1911
Ares	7725	2300	Feb. 1912
Artemis	7725	2300	Feb. 1912
Elbruz	9560	2900	Apr. 1912
Selene	7725	2300	Apr. 1912
Hermes	7725	2300	Apr. 1912
Poseidon	1340	450	May 1913
Utrecht	2360	800	July 1913
Lara	1575	650	Aug. 1913
Hestia	1575	650	Feb. 1915

In addition they have nine Vickers-Diesel engined vessels, and one tanker of 1575 tons displacement equipped with Kromhout surface-ignition oil-engines. As the operation of their motorships covers the period between the end of 1910 and now (the first ship taking only six months to build) they are in an excellent position to judge whether or not Diesel ships are successful. Yet—astounding as it may seen—many shipowners who have never been aboard a modern full-powered Diesel-driven ship actually have formed the opinion that these craft are unreliable.

When we analyze the reason for this extraordinary belief, we usually find that some friend of theirs has been operating an under-powered wooden motor-auxiliary sailing-vessel, or else some business opponent of the oil-engine has been filling their minds with unfounded rumors of huge repair bills and long delays in port.

In view of the above performances, the reliability cannot be further doubted. Here we have a ship of 10 knots speed, which completed 25 voyages, totaling 43,968½ nautical miles at an average speed of 9.6 knots regardless of all kinds of weather conditions. **We put it to every fair-minded steamship owner that such a performance is equal to, if not better than the most reliable cargo steamer.** The fuel-consumption averaged 6¾ tons per day.

Incidentally we draw attention to her cubic-capacity (gross) of 209,122 cubic feet of oil cargo. Where could a steam-driven tanker be found that has the same capacity on the same dimensions and average-speed as the "Artemis," namely 360 ft. by 46½ ft. by 27 ft. 5 in.?

Let every shipowner realize that a steam-driven tanker of 209,122 cubic-feet capacity (excluding bunkers) would have larger dimensions and higher-powered engines—so would cost more—and would have a daily fuel-consumption of 25 tons of oil, compared with 6¾ tons burned by the motorship "Artemis".

Those who maintain that Diesel-engined ships are unreliable, or are not economical on comparatively short voyages, especially small ships, are warmly invited to express their opinion regarding the above figures, or—as the parson puts it—"hereafter hold their peace"!

ENGINEER'S LOG OF M. S. "ARTEMIS"—NEW ORLEANS TO SHANGHAI

May	Revolutions per Minute.	Revolutions per Day	Slip %	Distance Run By Screw	Distance Run By Ship	Consumption per Day
4	110	159690	3%	241.4	234	6.9 Tons
5	109	158900	4%	240.2	229	6.9 "
6	110	159470	5%	241.1	229	6.9 "
7	111	152500	2½%	230.55	234	6.9 "
8	111	161800	½%	244.6	243	6.9 "
9	110	161000	9%	243.37	222	6.9 "
10	110	159870	2.7%	241.7	235	6.9 "
11	110	159540	5%	241.2	229	6.9 "
12	110	160570	7%	242.7	226	6.9 "
13	110	159950	4%	241.8	231	6.9 "
14	110	159700	12%	241.4	212	6.9 "
			to pass 180° Meridian			
16	110	156900	5%	237.2	225	6.9 "
17	110	160520	3%	242.6	235	6.9 "
18	110	160310	2%	242.3	237	6.9 "
19	110	160440	3%	242.5	235	6.9 "
20	110	160460	3%	242.5	234	6.9 "
21	110	160240	4%	242.4	231	6.9 "
22	111	160950	3%	243.4	235	6.9 "
23	110	159700	4%	241.4	231	6.9 "
24	109	158660	10%	239.8	214	6.9 "
25	109	158720	9%	240	218	6.9 "
26	109	158100	10%	239	213	6.9 "
27	108	156870	10%	237.1	212	6.9 "
28	110	159810	6.8%	241.6	225	6.9 "
29	109	158810	8%	240.1	220	6.9 "
30	108	156350	13%	236.3	205	7.2 "
31	110	24500	10%	37	33	3.7 "
June 1	...	.....	.....	.....	...	5.3 "

Oil used on voyage.....188.7 tons
Average used per day.....6.9 tons
Draft Forward.....20′ 2″
Draft Aft.....23′ 4″

Time on Voyage.....26 days 7 hrs. 26 min.
Oil Engines: 4 Cycle—Direct Reversible Diesel Engines.
Cubic Capacity (Gross).....209122 cu. ft.

M. S. "Artemis"—strd. Twin Screws

Deadweight.....5140 tons
Gross.....3803 tons
Net.....2312 tons
Length.....360′ 0″
Breadth.....46′ 6″
Depth.....27′ 5″
Cylinder Diameters...H.P. 20 2-5″ B.H.P. 1800
Stroke.....H.P. 35 2-5″ I.H.P. 2200

(Signed) C. ZULVER, *Marine-Superintendent.*

This company has in service eleven oil-carrying motorships fitted with Werkspoor-Diesel engines, as follows:

SPEED OF STANDARD OIL CO.'S NEW TANKER

In our issue of November we mentioned that the 1100 shaft h.p. to be installed in the new Diesel-driven 2800 tons d.w.c. tanker building for the Standard Oil Co. of California, should be capable of driving the vessel at an estimated speed of 11.2 knots when loaded to 17 ft. 6 in. mean draught. This was a little point which we overlooked. While she may do this speed under favorable conditions we should estimate that an average of 10 to 10½ knots would be a fair speed for the power.

ANGLO PERSIAN OIL TO INCREASE CAPITAL

About two years ago we forecasted that after the war the Royal Dutch-Shell oil-combine would open up the Messopotamia oil-field in a manner that would seriously challenge the U. S. and Mexican oil output and that low transportation costs would be obtained by the use of Diesel-driven tankers. The start has come in the recent increase of the capital of the Anglo-Persian Oil Co. Ltd., to $100,000,000.00. The British Government virtually controls this branch of the Royal Dutch Co.

ANOTHER ROYAL-DUTCH SHELL EXPANSION

One hundred thousand shares in the Steaua Romana Company have been purchased by the Royal Dutch-Shell oil group from the Deutsche Bank and the Disconto Co. of Germany. This makes the Royal Dutch-Shell group the largest oil producers in Rumania, it already controlling the Astra Romana Company. The present production, recovering from stoppage caused by the war, is half-a-million barrels per month.

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World's Highest-Powered Naval-Type Diesel Engine

The Augsburg 3000 Shaft Horse-Power Heavy-Oil Engine for German Submarine-Cruisers

(Exclusive to "Motorship")

It was at the Augsburg Works of the Maschinenfabrik Augsburg-Nurnburg that the Diesel-engine was originally developed by the late Dr. Rudolf Diesel with the valuable assistance of Herr Imanuel Lauster, the Chief-Engineer of that plant, and it is to the ability of the latter that the high-compression type of internal-combustion motor, now universally known as the Diesel oil-engine, owes its success. All engineers thoroughly posted with the construction of the Diesel-engine in Europe admit that during the entire history of its development there has been no better built machine, or of more sound design than the Augsburg, and it always has been way ahead of the Diesel-engine constructed at the company's other works at Nurnburg. Lauster has always refrained from radical departures from recognized engineering practice and all along has adhered to a sound conservative design, resulting in the pre-war Augsburg engine being not necessarily the finest in the world—, but a machine that was second to none in workmanship and reliability. So we will give that much credit to our late enemies.

When in Europe we were enabled to see a pair of 3,000 shaft horse-power Augsburg Diesel engines built for the large submarines of the German Navy, and later, when a pair were shipped to the U. S. Navy Department by Captain E. C. Tobey, head of the U. S. Shipping Board Emergency Fleet Corporation in London, we were able to secure the illustrations given—this through the courtesy of the Secretary of the Navy. As this is the first description to be published in any country, the same will be of the greatest interest to the engineering world. Until the first set of 4,000 b.h.p. Sulzer submarine-cruiser engines are completed by Japan, this Augsburg 3,000 b.h.p. model is the highest-powered naval Diesel engine in the world.

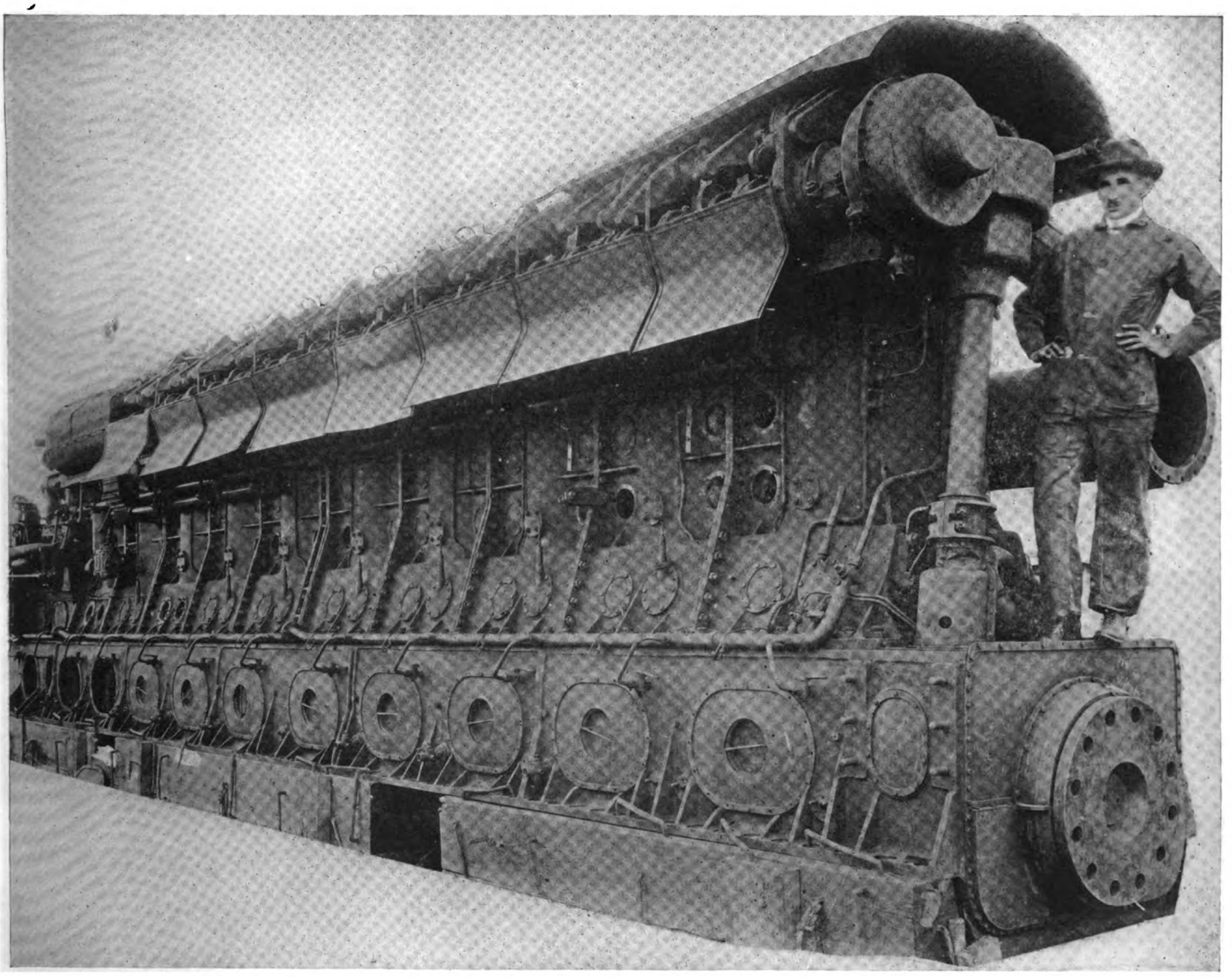
The very complete technical details which we give portray the very latest war-time Diesel engine developments in Germany, so we have given ample space to the illustrations and description in order that the article shall be of the greatest possible value to American engineers. Up to the time of writing no technical information regarding this engine has been published in any country, so once more "Motorship" scores in its service to readers.

After the many reports of exceptional mechanical-excellence and service-reliability which have been current throughout the world concerning the Diesel-engine development in Germany during the war, it was with avidity that we inspected the engine. As careful and thorough examination as possible was made as far as the outward appearance goes, as no authority was secured to dismantle any part.

To say that we noticed many innovations from usual practice is putting it mildly. They impressed us both favorably and otherwise, but in all cases a ready explanation was obvious and considering either the limitations of service, the emergency or lack of proper materials every detail was carefully and successfully worked out to produce a remarkably compact, light, accessible, and, as we know, reliable engine.

These said characteristics seem to have dominated the minds of the designers. A "minimum of excess strength"—hence light weight—is continually in evidence and the low overall height was undoubtedly made imperative by the low head-room available in the submarines. Other limitations with which the designers had to cope was the lack of any copper or brass for piping, valves, stuffing boxes, unions, etc. The only brass or copper of any account found at all was the tubes of the air-compressor intercoolers and, of course, the bearing metals. All intake ducts, were a white-metal alloy with the appearance of aluminum. So under the circumstances the production of such a high-powered engine is a remarkable piece of engineering.

In a general way we can mention the larger parts of interest which are noticed upon first walking around the engine. It can be seen that the engine shown is the starboard unit of a twin-screw installation and is a 10-cylinder, 4-



Front side of the Augsburg 3,000 shaft H.P. (4,000 I.H.P.) four-cycle single-acting, reversible, submarine Diesel-engine, built by the Maschinenfabrik-Augsburg-Nürnburg of Augsburg, Germany, for submarine-cruisers. The man affords an idea of its size

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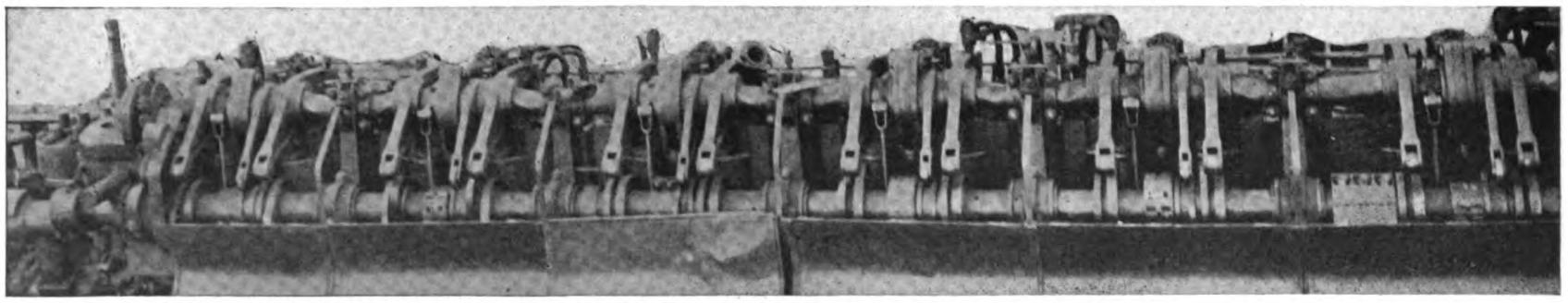


The Augsburg valve-operating mechanism.

cycle reversible high-speed engine reported to be designed to run at 385 r.p.m. When in England the bore and stroke was given us as being approximately 21 in. x 21 in. respectively, but so far as can be determined by measuring the assembled parts, the bore and stroke is 20⅞ in. x 20⅞ in.

The following are the main dimensions of the engine:

Length OA	37 ft. 5 in.
Height (Bottom Bedplate to Top Valve Rockers)	11 ft. 6 in.
Width	5 ft. 0 in.
Bore and Stroke	20⅞ in. x 20⅞ in.
Weight	75 tons
No. of Cylinders	10
Power (Shaft	3000 B.H.P.
Power (Indicated)	4000 I.H.P. (about)
Engine Speed	375 R.P.M.

Regarding the large submarines in which some of these powerful engines were installed, they are as follows:—

Displacement (submerged)	2785 tons
Displacement (surface)	2158 tons
Power (surface)	6000 B.H.P.
Power (submerged)	2600 B.H.P.
Length	320 ft. 0 in.
Breadth	31 ft. 6 in.
Depth	17 ft. 6 in.
Speed (surface)	18 knots
Speed (submerged)	8.1 knots
Bunker capacity	451 tons
Cruising radius (low speed)	20,000 nautical miles
Complement	83 men

There also is one 500 b.h.p. Diesel engine, either for slow-speed cruising or for auxiliary purposes.

Two German engines of 950 shaft h.p. also have been shipped by the Shipping Board from the Wallsend Shipway & Engineering Co.'s yard at Newcastle-on-Tyne. And, it is likely that a German submarine Diesel engine of 1750 shaft i.h.p. will be shipped very shortly.

This latter engine weighs 45 tons, and is 28 ft. 8 in. long.

Control of the main engines is at the forward inboard end, and is concentrated in the two vertical levers and the lower of the two small handwheels. The upper handwheel is for regulating the first-stage suction of the air-compressors. There are two single-crank two-stage compressors at this end on an extension to the main shaft with a bearing at the outer end only. All fuel-pumps, one for each cylinder, are driven off a common crosshead, the casing of this pump drive being shown in the foreground of one of the illustrations. All the fuel lines, in fact, every bit of piping on the engine is steel tubing with welded flanges,—even the connections where cone-joints are used are steel.

Moving around to the port side—for further casual inspection we see the separate intercoolers for the two compressors, the five-piece lower crankcase and bed-plate and the ten box-type cylinder castings with two handholes in each. It will be notice that one is fitted with a blank cover and the other with a screen. Over this screen is a complete, or partially so, paper gasket. It is as though that the latter were meant for breathing holes and were later covered with paper to keep in the oil.

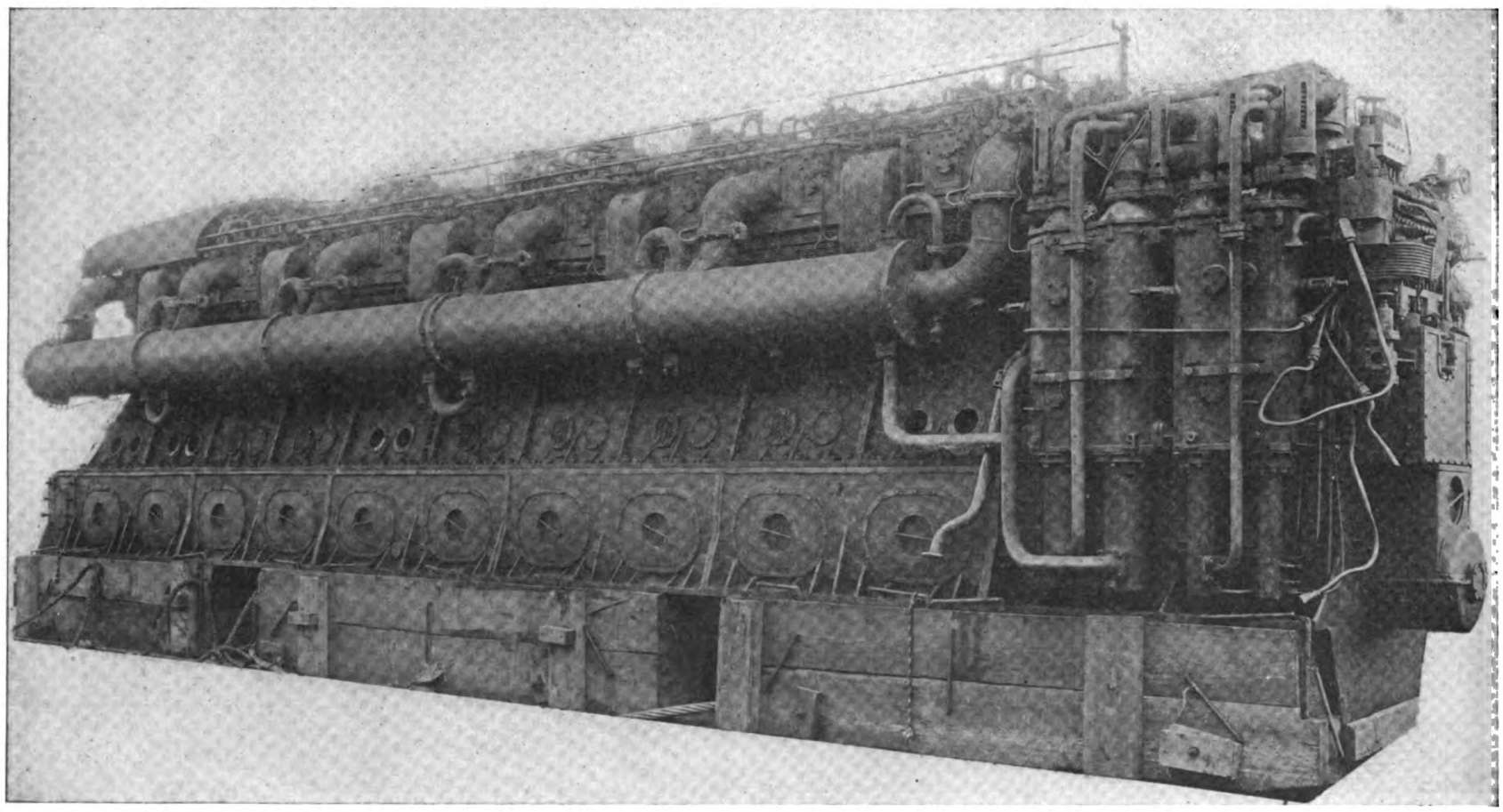
Most remarkable in this view is the 17 in. inside diameter steel-welded exhaust-header. This is shown in five pieces with a distance piece between cylinders 5 and 6 to correspond with that between the cylinder castings at this point. This header is of sheet steel with a longitudinal welded seam. The cooling-water space, tinned on the outside of the inner pipe and on the inside of the outer jacket is hardly a good quarter-of-an-inch in thickness. Welding is also used for the connection of this jacket wall to the end flanges. When it is mentioned that these sheet-steel tubes appear to be about ⅛ in. thick; that the header flanges are about 20 in. in diameter and only ⅝ in. thick connected with 16-7/16 in. dia. bolts, an idea is gained of the scant margin of strength and the extremes to which the designers went to keep down the weights. All the pads for the cooling-water by-pass bends are welded on.

Superlatives might well be used on this subject when attention is drawn to the seven part butt-welded elbows and Y-bends connecting the several pairs of cylinders to the exhaust header. Similarly the inlet ducts of some aluminum alloy are welded along the corner seams. These suction-pipes lead to a large flat plate that is well slotted, and which is mounted opposite the space between the cylinders formed by the box-shaped sides of the cylinder castings.

Leaving several piping details until later we proceed to the inboard side of the engine. This is as usual the cam-shaft side and the general arrangement of the inclined upright drive-shaft is quickly noted. This scheme results in keeping the overall breadth of the engine within that at the bed-plate; which, by the way, is only 54 inches from c. l. to c. l. of the holding down bolts. Helical teeth are used in the gears for the camshaft drive and a continuous bath of oil is assured for both upper and lower gears.

As mentioned before, the separate pieces of the crankcase extend for two cylinders, or from centre to centre of alternate main bearings—this distance being 68½ inches. The height of these castings from the top of the crankcase to the underside of the holding down flange is 27¼ in. From this space to the bottom of the crank-pit is 19 in.

These crankcase castings are in a way the outstanding feature of the engine. Generally speaking—there is no part thicker than 1¾ in. at the most—all main stiffening-webs are from ½ in. to ¾ in. thick and there are few flat surfaces more



Back view of the 3,000 shaft H.P. German submarine Diesel engine. It is a well-built machine and four such sets in conjunction with electric-transmission would furnish reliable propelling-power for a moderately fast liner of large tonnage.

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than eight inches across that have not a lightening-hole in them. And they are of cast steel. We doubt if such patterns could be cast in this country without extensive study and experiment for the shrinkage strains on cooling with the best grades of cast-steel must surely be quite indeterminate, but undoubtedly severe. The metal probably is the so-called "electric-steel" in which the ingredients are positively known and the composition and structure of the resultant steel is under positive control and of absolute uniformity.

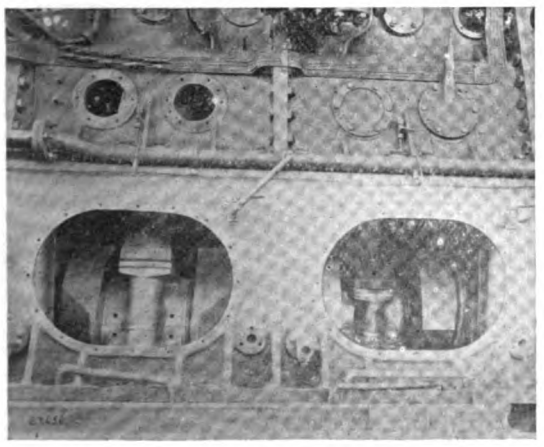
Returning to the contemplation of the view of the crank-case—we see the forced lubricating-oil piping moving along its upper edge of the crankcase with branches leading to each main bearing. For these, holes are evidently drilled in the journals and through crank-webs and pins so that the wrist-pin gets forced lubrication also. Between each lead of ¾ in. pipe to the main bearings may be seen a small ⅛ in. pipe leading over the large main pipe into the upper crankcase. These are for the cylinder lubrication. Each pipe branches into two leads after rising to about the height of the lower pairs of hand holes and they completely encircle the cylinder wall. There are four points of lubrication—they being at the quarter points around the cylinder and not over the line of the shaft nor 90 in. away from it. Having both branches joined on the far sides eliminates the possibility of any or all of points of lubrication being blocked-off due to any clogging between any two points around the cylinder.

Mounted on cylinder No. 1 (after end) are plug cocks for intermittent filling of various oil-wells and also continuous pressure lubrication for various parts of the camshaft drive that require it. The after hand hole in each cylinder casting—just above the lubricating-oil pipe is fitted with a plate carrying a guide for a hooked rod for the indicator gear. It is connected by a small line to the swinging rods of the piston oil-cooling system to be described presently.

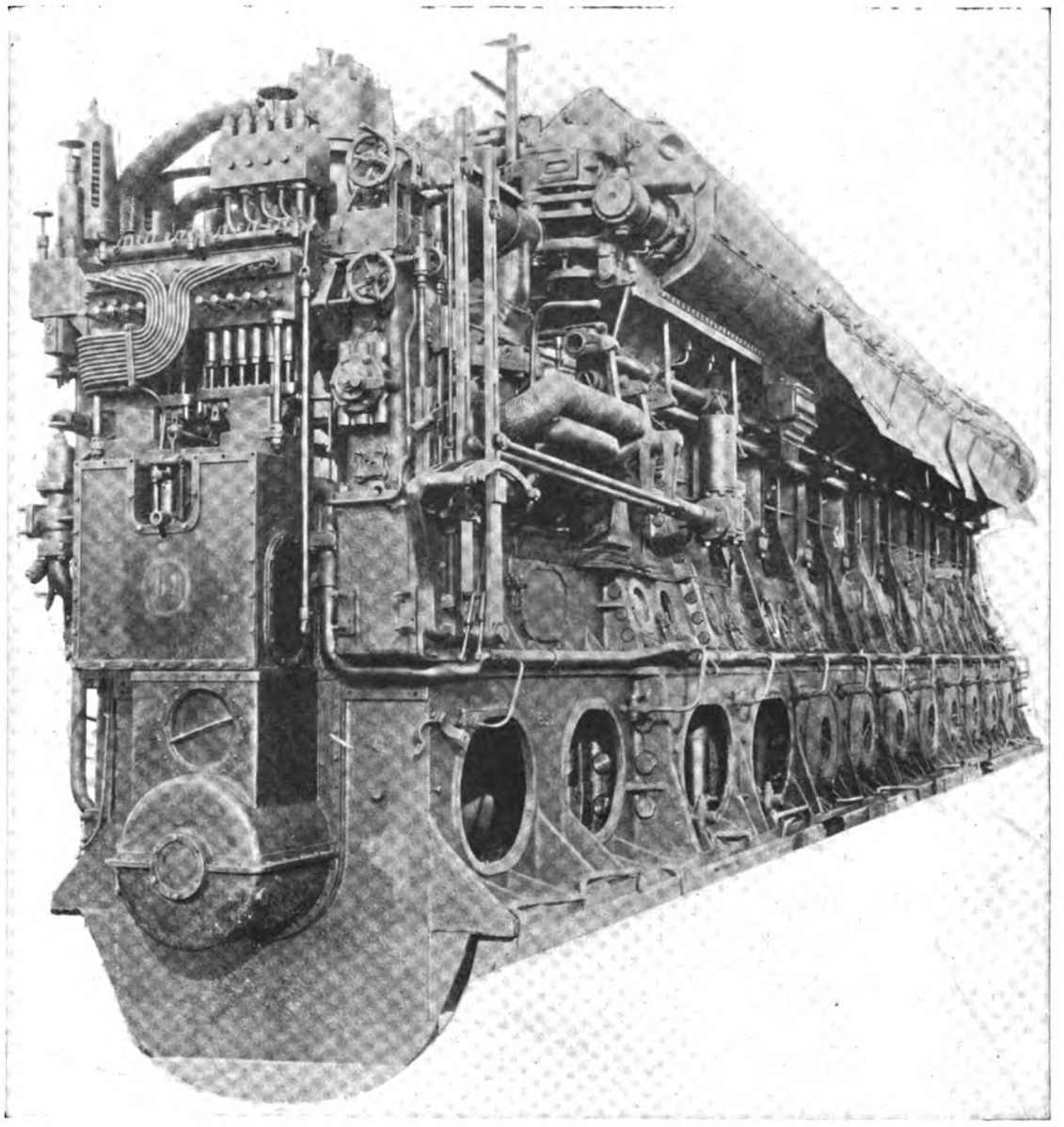
Passing on toward the forward end we notice the mechanism for air-starting and fuel-injection control. Before describing this however, attention is called to the plug-cock connections along the base between the crank-case manholes. These are for the piston oil-cooling system,—one for inlet to a stationary cast-iron receiver visible just inside the manholes in each crankcase and the other for the outlet. From the upper end of these cast-iron receivers a 1½ in. pipe rises about 4 inches and ends in a swivel-joint forming the first point of the swinging-pipe which is connected by a hollow link to a socket attached on the inside of the piston. From the latter a ¾ in. pipe leads up to the cylinder-head. The outlet is arranged similarly on the other side of the connecting-rod. About two-and-a-half inches from the pivot or outer end of the swinging-rod is attached the lower end of a small link-rod about eight inches long which operates the indicator gear mentioned above.

Taking off a few crankcase plates we were struck with several important features in quick succession. The apparently heavy crankshaft and lower-end connections,—the neat manner of lightening the connecting-rod, which naturally contributed toward compactness and lower inertia stresses, and the large but comparatively light main-bearing caps.

All the points mentioned may be readily noted. Close scrutiny will disclose the I-beam or section adapted to the main bearing cap. This cap is about twenty-one inches wide, twenty inches deep over the bed-plate, and 12½ inches long. It was but possible to determine the diameter of the main-bearing journal or that of the lower end bearing, but they were approximately thirteen inches in diameter. Between the inner cheeks of the crank-webs the distance measured 12⅝ in., giving an effective bearing-surface on the crank-pin of 10⅞ in. Locknuts with cotter-pins were used on the lower ends of the connecting-rod bearing bolts.



Illustrating method of lightening connecting-rod big-end and main-bearing caps.



Forward end of 3,000 h.p. Augsburg ten-cylinder engine showing fuel-pumps.

The crank-webs are 14 in. wide and 5 in. thick. Owing to the lack of time due to the increasing darkness we were unable to satisfy ourselves as to how the crank-shaft is built-up or coupled in the centre between cylinders 5 and 6, but are of the opinion that the centre journal is fitted with solid flanges turned at each end similar in size to that shown at the after end view, and the crank-web increased in width and countersunk to allow cheese headed-reamed coupling-bolts to set in flush with the inner face of the crank-webs. The very small increase in the distance between these two cylinders (only 4 inches) even suggests that the whole ten throws of the crankshaft were built-up.

It may be noticed that all the bolts joining separate parts of the crank-case and bed-plate are placed inside, there being a total of 22 bolts in each joint. All are fitted with a cotter-pin, and the coarse thread used seems to be adhered to throughout all such parts on the engine and all are provided with a deeply-milled spot-face sometimes about ¼ in. deep.

Upon beginning to examine the moving parts mounted on the engine we immediately saw the smallness and almost frailness of the various links, rods, and levers rendered necessary by weight restrictions. Perhaps the most interesting of all the mechanisms employed is that for lifting the valve-rockers and shifting the cam-shaft. By referring to the illustrations, this can be seen at the forward end of the shaft. In line and to the right of the upper end of the outer control-lever will be seen a gear-casing on which is mounted a little window. Within this casing is a spur-gear mounted on a vertical-shaft and meshing with a toothed-rack for which the casing can be seen extending to the right above and beyond the end of the camshaft. This rack is an extension of a pneumatic-ram which operates in the same line across the engine.

On the vertical shaft, on which the horizontal gear are mounted, are arranged cams and slotted discs. Above is a bevel-gear meshing with another mounted on the shaft carring the valve-rockers. By mounting these rockers eccentrically on this shaft, movement of the reversing piston rotates the shaft and raises the rockers off their cams. Fore-and-aft movement of the camshaft is obtained, after the rollers have been lifted, by the action of the afore mentioned cams on the levers or palls visible under the little window on the gear-casing. Mounted on this gear is a dial, which is visible through the window to the operator, who can tell at any moment the actual position of the maneuvering gear. Thus, if after the operation of changing the direction of rotation is commenced, and the gear should jam for any cause, the operator will know without examining it just how far the maneuvering had proceeded and perhaps in this way where to look for trouble. In one of the illustrations the short link connecting the crank in the near end of the upper shaft is locked by the flat disc shown fitting into a slot in the small rocker-arm. When the camshaft is shifted and rocker-arm rollers have been lowered a notch in the disc registers with the slotted-finger, and the air-valve rockers may then be brought down on their cams for starting. We were able to see that the inner control-lever operates the starting-air for the forward five cylinders through the shorter and lower of the two shafts and that the outer lever turns the long shaft through a similar pair of bevel-gears to control air to the after five cylinders. A small line is operated by this latter shaft to open and close the valve on the starting air-line—this valve being very prominent in one of the illustrations.

Attention is called to the following features which are self-explanatory. The suction for the air-compressor first-stages is shown neatly combined into one muffler. The little handwheel visible beyond is geared to a revolving-sleeve giving control of the first-stage suction. All discharge pipes from each stage are covered with the screening as shown. Note the oil-lines to the working parts of the air-compressors. There is a gang oiler for this system.

A few remarks on the fuel-pump may help to understand the manner of control. The small hand-wheel on the level with the pump-body controls the amount of fuel pumped by means of levers and links provided with interlocking devices not shown and partly dismantled which it will be unnecessary to describe. This control finally terminates in the link and bell-crank mounted on the centre line of the engine below

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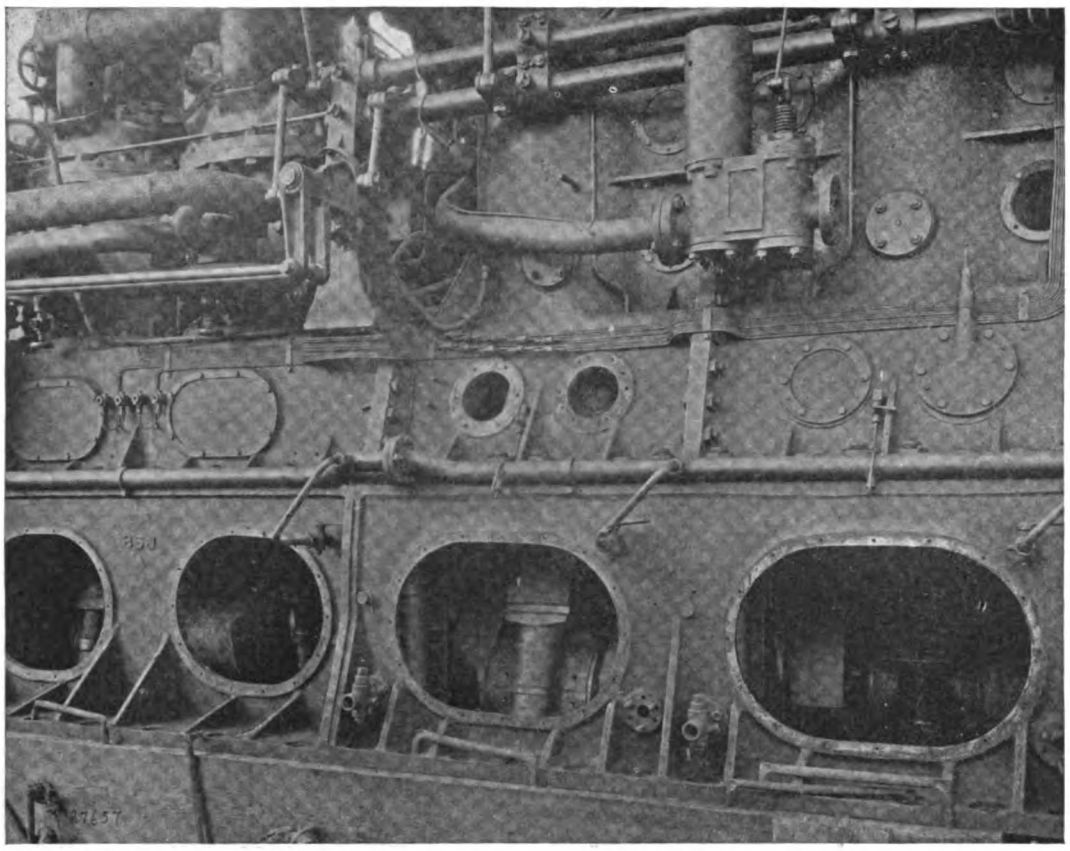


Close-up view of maneuvering-gear, air-compressors, and crankshaft of 3,000 b.h.p. Augsburg engine.

the pump plungers. The vertical link goes down inside the casing to a loose eccentric which drives the single crosshead through a long connecting rod. This crosshead drives the two plunger-rods to which are connected the two groups of five fuel-valves. Hand priming is performed by working the flanges shown entering the ofrward side of the pump body. Above the line of discharge pipes may be seen a shaft carrying ten little tappets and a short crankarm at the right and from which hangs a long link. This is the control of the suction to each pump and it is difficult to say just how it is connected up.

The loose eccentric mounted on the extension of the air-compressor cranks varies the amount of eccentricity, hence the stroke of the pump-plungers. There is also a centrifugal control on the same shaft which will act automatically at overfeeds.

Following the fuel-lines around and along the engine we see that each line enters a small by-pass valve from which a pipe runs to a common return pipe, which can be seen as the bottom pipe of the fuel lines and it is this pipe which may be seen turning downward from the bank of ten tubes from the fuel-pumps. From each pressure relief by-pass or overflow check-valve mounted on each cylinder two wall-pipes enter the double fuel valve body.

A noteworthy feature of this engine is that it uses two injection-valves simultaneously—these valves opening outward and operated by the single rocker-arm are about eight inches apart. The bottom of the cylinder-head is quite flat and the piston-head very slightly disked. It was not discerned by what method the designers insured equal quantities being pumped to both valves, although each fuel-pump works twice to every injection into that cylinder.

A few additional remarks on the arrangement and details of the cylinder-head mechanism will finish the description of the mechanical features of this engine. All piping both for water, fuel, air-starting, exhaust and inlet is arranged to serve the cylinders in pairs. This is illustrated by the alternate arrangement of exhaust and inlet valve pipes. Both the exhaust-valve cages and the valves themselves have separate cooling-water circulation. In the case of the valves the connections may be discerned in one of the and are of flexible hose encased in a braded-cord covering. The cylinder-heads are octagonal in shape and a cylinder-head holding-down stud is located at each corner, making eight per cover.

These studs are very short, extending only about 3½ inches above the cylinder-liner joint and the bolt is elongated to resemble a hollow pin—threaded inside,—at one end to match the stud and with a narrow shoulder about 2½ inches below the upper end on the outside. This shoulder takes the combustion-pressures to each stud. These nuts when set up do not project above the cylinder-head—they being finished with a hollow-square inside into which a square-plug may be inserted for turning the nut. This scheme results in a gain of at least twelve inches of head-room as it is only necessary to raise the head about 3½ in. to clear the studs. All valve-springs—except the relief-valve are placed below the rocker-arms—none being visible in the illustrations. The links operating the secondary or loose eccentric-bearings of the fuel and air-starting rockers for each cylinder are visible. Each fuel-valve rocker is seen to work on the inside of the camshaft. This gives the desired lightening effect to the valves at the other end of the rockers. Thus when the fuel-valve rollers are swung away from their cams the air-starting rollers approach theirs.

Special attention is called to the fuel-valve cams. They are only half-rings inserted in grooves, and by means of a screw adjustment at each end of the cam—any desired position within limits—may be given to the nose of the cam. This adjustment can, of course, only be made with the engine stopped and would seldom be used except for a great change of oil-fuel characteristics, etc.

A very compact yet quickly accessible design for supporting the rocker-arm shaft, yet providing for breaking the joint between each cylinder head is fitted. A coupling is provided having a journal finish on the outside with the clamp bolts and flanges outside of the bearing. The pedestals that carry both the rocker shaft and camshaft bearings between each pair of cylinders is very tall, lightly built and unstable looking, but as always—any suggestion as to weaknesses—may quickly be answered by pointing to the excellent service given by this type and by smaller engines placed in Germany's submarines.

In this connection the question has been raised and the opinion expressed that Germany's submarine engines were not designed for long life, but to fully and promptly meet an emergency. Already the machinery installed in some of the submarine boats has been found racked to pieces and ready for the scrap pile. More because they were designed for a short life of intensive use with the expectation and purpose that both hull and machinery should be sufficient into the hour of need and no more.

RECORD OF THE DIESEL FERRY "VASHON ISLAND".

ONE of the greatest fields for the utilization of the heavy-oil engine in medium-sized units is to be found in the thousands of ferry boats that are used to carry passengers on the rivers and inland waterways of the country. Every town, hamlet or city, that is located on a stream or a bay has one or more boats of this type, most of them now operated by steam side or stern-paddle-wheel engines. Without exception these boats could all be more economically and satisfactorily propelled by internal combustion engines of the heavy oil type. At least, that is the conclusion to be drawn from the record of the ferry boat "Vashon Island" which operates on Puget Sound, carrying passengers and vehicles from Seattle across to the towns and ranches on Vashon Island.

The "Vashon Island" it may be remembered was built for the King County Commissioners for this service in 1916, going on the run between Des Moines, a suburb of Seattle, and Portage on Nov. 1st of that year. She has operated there continuously ever since, the regular service having been interrupted only for the annual inspection and overhaul. The facts about the operation of this engine have been obtained direct from the King County Commissioners and the chief engineer, Mr. Ed. J. Dickson, and show that the type of power plant has been a great success.

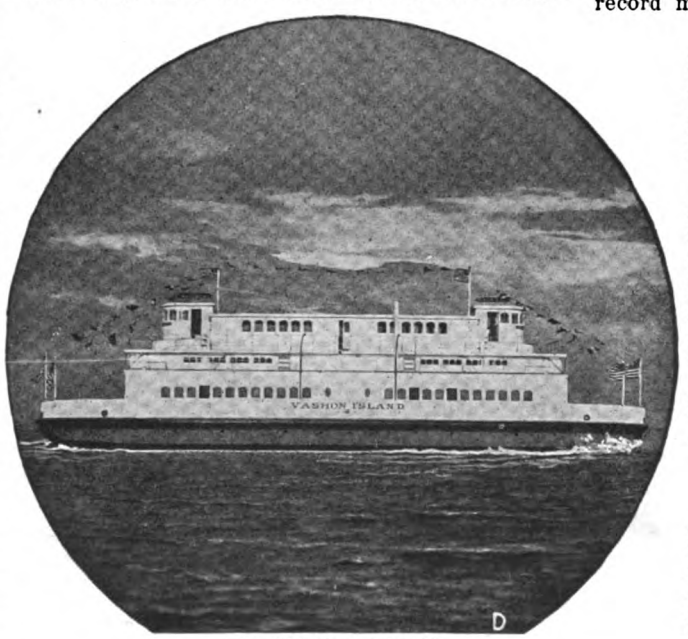
Mr. Dickson states that the engine handles the boat easily and dependably under the most exacting requirements of a service consisting entirely of short runs and head-on landings. The engine is of the non-reversible type, being equipped with a disc clutch and flywheel at either end. The original plates are still in use, having been engaged and unengaged from two to three times in the making of each of nearly eight thousand landings.

When the engine was first installed some trouble was encountered at the start with cylinders cracking, but new ones, cast heavier at the weak point, have given complete satisfaction, and one or two early instances of cracked pistons have also been entirely eliminated in subsequent operation.

The engine is given a thorough overhauling at inspection time, and after about six months running, the pistons are pulled, carbon removed and valves reground; also the connecting rod bearings are set up if necessary. The main crank shaft bearings have not needed adjusting as yet.

The auxiliary set consists of a nine horsepower Atlas gasoline engine, an electric generator, a centrifugal bilge-pump, and an emergency air-pump, the two former silent-chain driven, and the latter gear connected, and all neatly mounted on a cast iron base. The engine room personnel consists of two engineers and an oiler.

The following table gives a summary of the record made by this installation:



The "Vashon Island"

FERRY BOAT "VASHON ISLAND"

Length	110 ft.
Beam	30.5 ft.
Draught	10.7 ft.
Gross Tonnage	283
Net Tonnage	238

Engines

Atlas Diesel, 4 cycle 6 cylinder, non-reversible	
Rated Power	250 H.P.
Rated Speed	250 R.P.M.
Operating Speed	240 R.P.M.
Cylinder Bore	11½ in.
Stroke	14 in.
Fuel per H.P. hour	.55 lb.
Lubricating oil per H.P. hour	.0034

Route Travelled

Portage to Des Moines and return. Distance—round trip	10.6 Miles
Trips per day since May 1, 1919.. (Prevous to that date, 4 trips, with two or three additional Sundays during Summer).	6
Fuel used per trip (Diesel)	14.36 Gal.
Running time, round trip	74 min.
Trips made since Nov. 1, 1917	3,890
Landings (headon)	7,780
Miles Travelled	41,234
Hours running	4,624.3

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Some Large Diesel-Driven Submarines

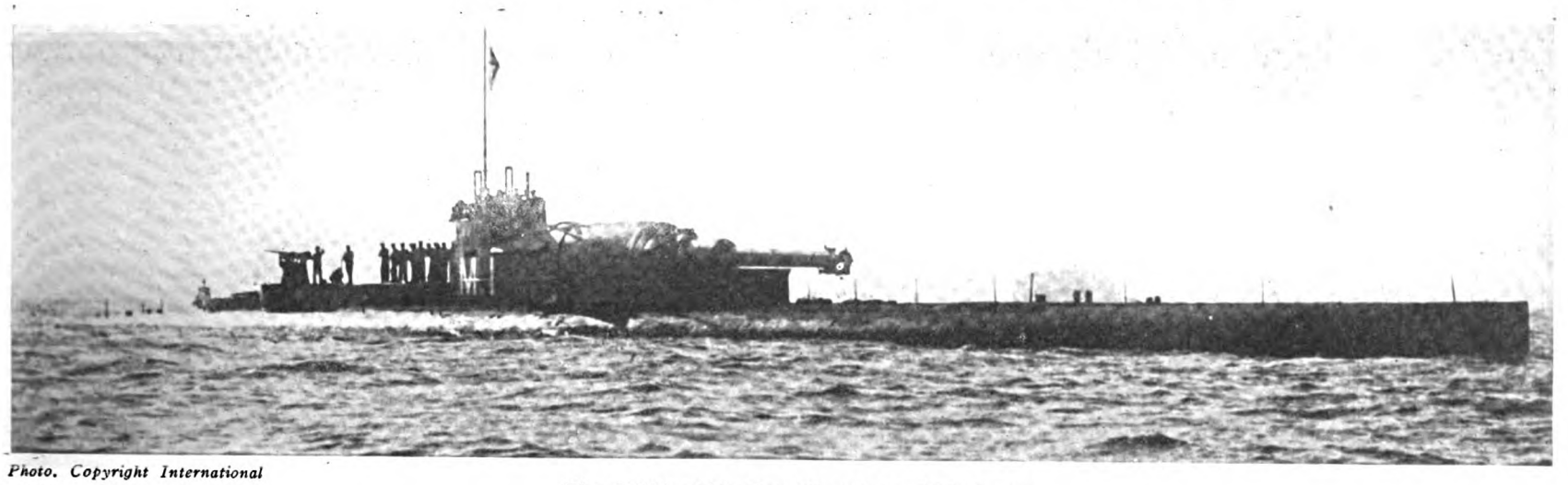


Photo. Copyright International

The British submarine M1 and her 12 inch gun.

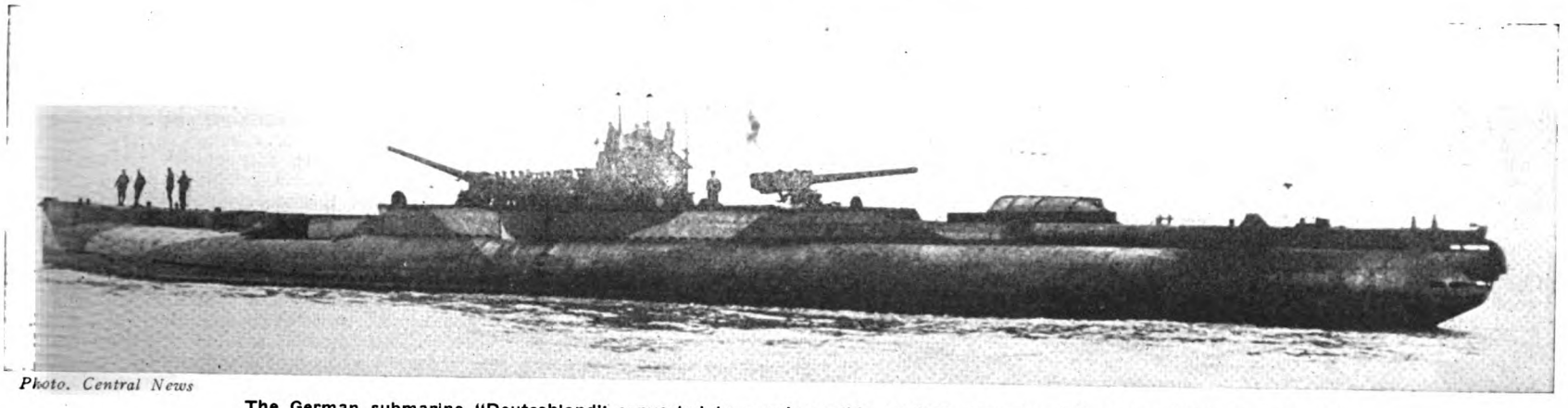
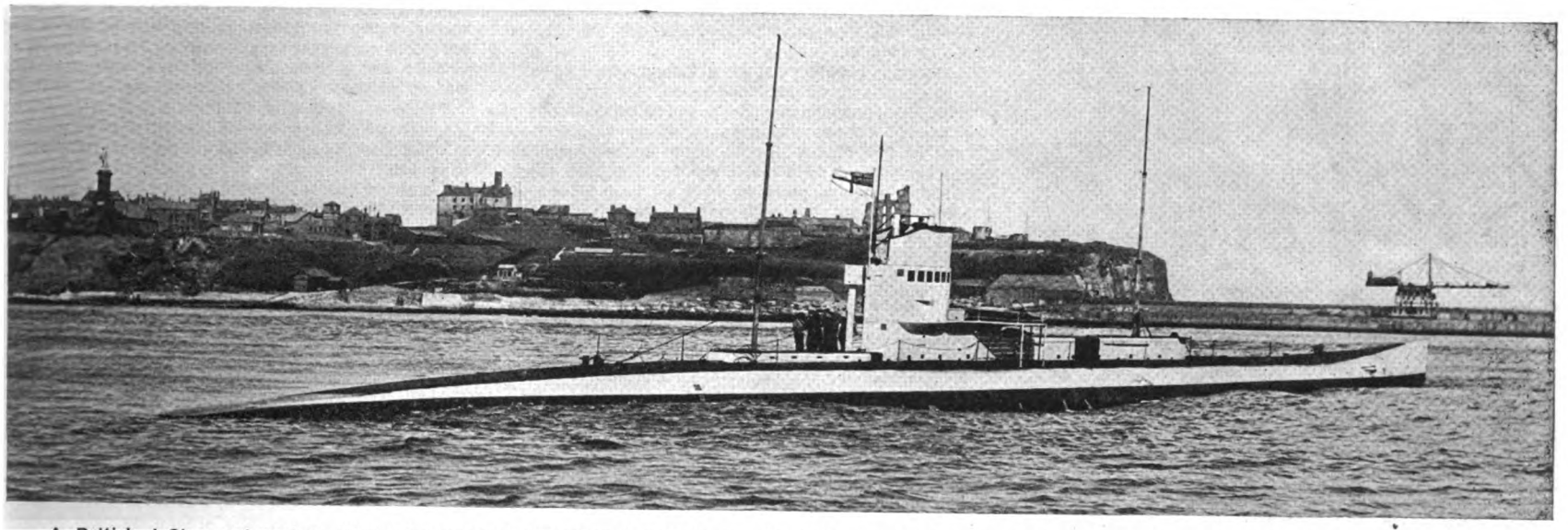
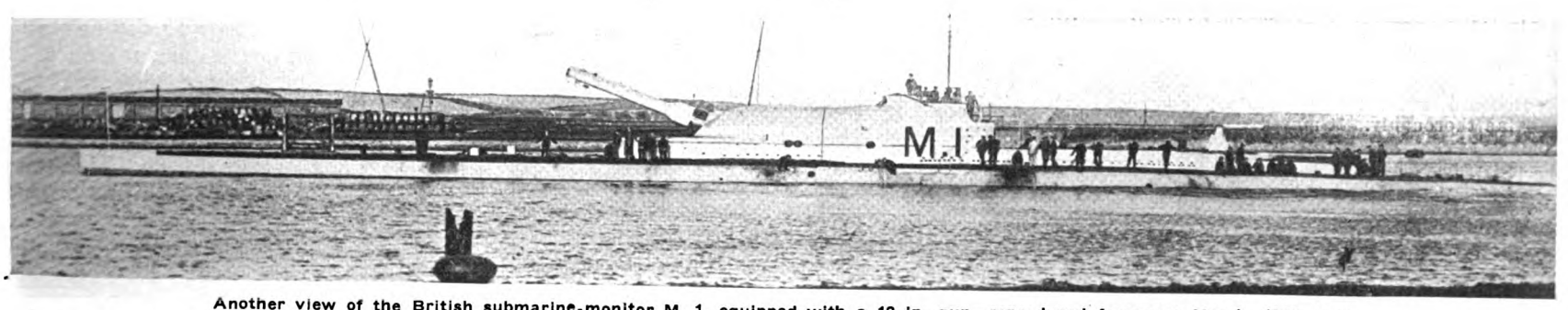


Photo. Central News

The German submarine "Deutschland" converted to a submersible cruiser—reproduced from our issue of Feb., 1919.



A British J-Class submarine. Her submerged displacement is 1820 tons, with 1210 tons surface displacement. Length O.A. is 275 ft., power 3,600 b.h.p. consisting of three 1200 h. p. Vickers-type solid-injection Diesel oil-engines. Speed 19 knots.



Another view of the British submarine-monitor M. 1, equipped with a 12 in. gun—reproduced from our March, 1919, issue.

Admiral Lord Fisher predicts Diesel-driven submersible-battleships, and the Japanese navy is to build 12,000 shaft h.p. submarine cruisers. The U. S. Navy Dept. does not believe in the big high-powered submarine. Our largest are the AA class, which are propelled by four 1000 b.h.p. Nelseco-Diesel engines. Heavy guns are not carried.

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Obtaining Reliable Motorship Operation Data

How Shipowners Can Distinguish an Engine of Practical Design From One Incorporating Features Mechanically Incorrect—Comments on the Two-Cycle versus Four-Cycle Principle

By M. O. TORIAN

[The author of this article is another of the prominent European Marine Engineers, who (under the above "nom-de-plume") will frequently contribute to the columns of "MOTORSHIP."—EDITOR.]

So much has been said about the saving of space and weight, the better economy, the larger action-radius, the reduction of crew, etc., resulting from oil-engine propulsion all of them giving in the end a saving of money which must appeal to shipowners, that we can refrain from beginning this paper by an enthusiastic eulogy of the motorship as such. None of these points can really be denied and it is no use convincing people of what may be said to be accepted truths. But—here is the big But with a large B—this saving of money can easily turn into a Big loss, if the motor is not a good one and the money gained on the fuel-bill and extra cargo-capacity is quickly spent if the ship is tied-up in some port for repairs. Now this is what many shipowners fear and which keeps them from going-in for motorships: the uncertainty whether there is a really good make of motor and if there is: how to know a good one from a bad one. One could say: "That is easy enough—look at the results." But, this is not quite as easy as it seems; in the first place the results often depend on the requirements that are put to the ship and secondly we must judge on the results by informations which may be more or less dubious and even contradictory. All information is influenced by a personal factor which may transform it to every conceivable grade between blind enthusiasm and malevolent slander. How is one to know the truth?

Let us look over the sources of information that are available and how far these sources may be considered trustworthy and useful. Considering the engineering papers first: Shall we take the advertising part for dependable information?

We are inclined to put this information too near the top of the ladder—the blind enthusiasm—as to give it a real value in choosing a marine motor. In some publications a part of the reading matter may really be regarded as advertising matter and should therefore be taken with careful discerning judgment. Another part is purely mechanical and descriptive, but very rarely critical. One can like a certain design or device described in the paper better than another; but, it is hard to tell whether the one is really more satisfactory than the other. You certainly cannot expect to find—say in a foot-note—that some described device won't work well at all.

Still another part will inform you about a remarkable voyage of some motorship—without stopping, without breakage or wear of any kind, etc.,—but who tells you what this same ship did the next trip or will do in coming years? Some think that a visit to the ship and a heart-to-heart talk with the chief-engineer is the best way to get dependable information on a certain make of engine. Apart from the fact that some engineers are instructed not to say anything and that it would certainly not pay them—to say the least—to tell anything bad about the engines,* it is very hard to judge on the merits of the engine, by seeing the engine-room or even several engine-rooms. Only a very experienced man that has been an engineer himself, preferably on a motorship, can. The condition of an engine or an engine-room is mainly the result of four components: the engine itself, the interest that the engineers take in it, the company the ship belongs to and the kind of service she is used for. Let us compare for instance two ships that are used in entirely different conditions. The first may be running to and fro between two ports, staying in each one of them a week or longer every time, with engineers that are experienced motormen, knowing their engine thoroughly. It may even be the case that in one of these ports the works are situated that constructed the engines—making it possible that all the repairs are done by experts and without the world at large getting anything to know about it.

The second ship may be a tramp, going all over the world from one port to the other with hardly ever a chance to get repairs decently done by machinists that have seen a Diesel-engine before. Chased around from port to port by an excess-profit seeking company the vessel never gets a rest and is often speeded-up inconsiderately, which is as harmful for a Diesel-engine as for a horse! The engineers, weary of being away from home too many years at a stretch run-off every once in a while and are replaced by steam-engine-men that may have no sympathy for a knowledge of Diesel engines, or shirk from the increased attention that they require.

It is clear that an engine which will make good on the first ship and show a perfectly clean record may be absolutely unfit for a ship of the second type and that a shipowner, who, going by this splendid record puts this make of engine on his tramp, may make a big mistake. The engine though, which makes good on a tramp of the above described type will make good anywhere. Therefore, one should try to find out which are the worst conditions in which the engines may be compelled to work and then see if they will take the bad usage. As to bad usage one hears the most unconceivable things and only the engine builder that has met with innumerable cases of this kind will be able to make an engine proof against a good many of them. What for instance if they run short of filter-cloth on board and the engineers just simply let the engine work with dirty oil? What if some engineer—who does not like any tom-foolery, and does not understand the purpose of the thing, takes out the pulverizers and makes the engine run without, never minding if the pressure in the cylinders runs up to 600 lbs. or more? What if he screws the safety-valves down, because he does not like the noise they are making when he starts the engine? All this may happen and I assure you that it actually has happened.

Only if an engine will stand good-naturedly this kind of hardships—if they are not really too bad—can we say that it is reliable. Therefore, look for this engine!

If reports reach you of a Diesel-engined ship having been put up for repairs of the engines, be sure you do not charge the engines with it before you know whether a steam-engine would have submitted itself, willingly and docibly, to the usage they tried to make the Diesel-engine take.

There is not so much in a small gain of weight or space if it has been bought by a complication of the engine which may make it less reliable. This brings me right to the question which has been so much discussed: four-cycle or two-cycle? The two-cycle engine may take less space and be less heavy than a four-cycle engine of the same capacity. Even this is questionable although it is put forward as a great asset by the two-cycle followers. But, is this worth the greater risk of engine trouble owing to the higher temperatures or the increased bearing pressures? Certainly, there may be a limit to the dimensions of four cycle engines, where we will be obliged to pass on to the two-cycle engine for more power, but below this limit there is no question about it in my mind, that one should choose the very simplest and most reliable engine available, a four-cycle one.

As long as there is a shadow of a doubt, whether the two-cycle is as reliable as the four-cycle and there are no other very important points in favor of the two-cycle engine there is to my mind no imaginable reason why one should take the chances. For the sake of the development of the two-cycle? Why, let those work for the development of the two-cycle that have to have more power than can be made in a four-cycle. Apart from the lesser economy (the two-cycle using at least 5 per cent. more fuel than the four-cycle), there are several engineering difficulties in the two-cycle that seem hard to overcome. Even if means have been found to overcome them I should like to see them put to the severe test of rough usage as above described. What will become of a crosshead bearing which has to be lubricated by oil under a pressure of about 300 lbs. through telescopic-pipes in order to keep cool? One fears to think of it! Yet, it seems that it is almost impossible to run a two-cycle engine without it.

Everybody knows that two-cycle engines have been taken out of several ships, but there are some of them left. It remains to be seen how they would take the treatment of a hackney-pony!

Yet this is the treatment that most engines get and if they will not stand it they are no good as marine engines, though they might do very well as stationary engines. It is very hard for a designer used to making stationary engines to get used to the requirements that a marine-engine has to fulfil. Lots of devices which he may use without hesitating on the former would be entirely misplaced on the latter and he can only appreciate this fact by making several trips as engineer on a ship. The kind of care an engine receives depends upon the state of mind of men in charge, and you can not expect a man that has been shaken-up by a rolling sea in an oil-saturated atmosphere to look at an engine in the same way as his better-fortuned colleague on the shore that returns every night to his cozy home.

It is a well-known fact that in most engines both four-cycle and two-cycle that go wrong, the failure is due to details—if one may call them so. It is usually not the principle, nor the general arrangement that will give an engine its bad reputation, but some leaking gland which you can't get at when the engine is running, a fuel-pump with a score of tiny little valves that have to be ground in every now and then, keeping the men on board when they should have liked to go on shore! How many of these disagreeable little details may be hidden in a nice looking, smooth, apparently, well-designed engine—like a tomb: a beautiful monument but full of rottenness inside!

It is not of so much importance whether an engine will reverse in 10 or in 12 seconds, but it is important if unexpectedly it will not reverse at all because of some complicated air-driven mechanism in which a non-return valve fails to close. It is not a thing of much consequence if the cooling-water pump is driven by a beam or by a crank, but it is important that one of the cylinders can not be for a considerable time without cooling-water, without your being obliged to notice it.

These are the kind of details a man should look into if he wants to judge on the merits of a marine Diesel-engine. There are too many people that fail to see that a reversing-mechanism may be altered in a hundred different ways—all of them working quite satisfactorily—but that it is not quite as easy and far more important to keep the sea-water out of the lubricating-oil, even with the most unconceivable carelessness of the engineers in charge.

Condemn the engine that has vital parts which can't be replaced without the help of the builders of the engine in any port of the world; condemn the engine that has parts which the average engineer will not understand by simply looking at them; condemn the engine in which you cannot get at the most important parts without first clearing away a number of pipes and breaking a score of joints; condemn the engine which presents itself so nicely to the eye, but is a perfect monster if you want to get at the crosshead-pins. Condemn it—if you don't, it will condemn itself in a few years and you will be sorry you ever went in for Diesel-engines. Which you should not be, as they have all the advantages claimed for them. You will not be sorry if you look before you leap!

*We have found the engineers of most ships very frank in their remarks.—Editor.

ORIENT COMPANY'S FIRST 10,000 TONS MOTORSHIP NEARING COMPLETION

It is anticipated that the first 10,000 tons d.w.c. motorship building at the Nakakov Shipyard for the Orient Company of Copenhagen, Denmark, will be completed by April next. This concern has a capital of $2,750,000.00, and last year paid a dividend of 80 per cent. As it is allied with the great East Asiatic Co., American steamships later on will have difficulty competing against their economical motorships in the Europe—U. S. A.—Far East trade. At present the Orient Co. are paying their crews four times the pre-war wages, but their profits are greater than ever they were, and the value of their 60,000 tons d. w.c. fleet has increased from $3,590,000.00 in 1915 to $13,250,000.00. Their reserve fund is $2,500,000.00.

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Testing High-Powered Marine Oil-Engines

Details of a Dynamometer That Has Been Adopted as Standard By the Majority of Engine Builders

(Contributed)

At a time when the Diesel engine and its application to the propulsion of ocean-going vessels is attracting the attention of engineers, both in this country and abroad, it is perhaps opportune to refer to an instrument, viz., the Dynamometer, which has contributed, in a small way perhaps, to the present high state of efficiency to which that type of engine has now attained. It would be well to preface these remarks by stating that a dynamometer is virtually a measurer of power—that is, by its use it is possible to ascertain the amount of power any particular prime mover can supply for the purpose of doing useful work—that is, its shaft horse-power output.

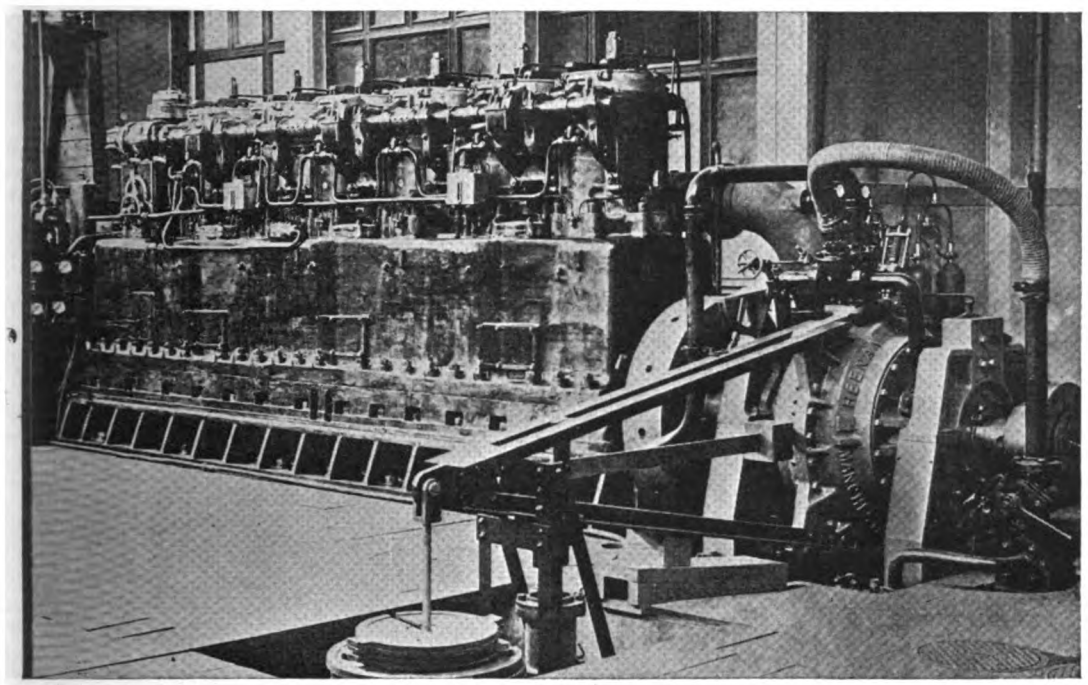

Fig. 1. A 950 h.p. Fiat San Giorgio Diesel engine developing its power on the test stand direct connected to a Heenan & Froude dynamometer. Note the dash-pot under the outer end of the lever.

This apparatus, although really a necessity in all engineering works, has not been used to any great extent at any rate until the advent of the internal combustion engine as it has been possible, especially in the case of marine steam-engines, to measure power by other standards—for instance, indicated horse-power.

I. H. P., however, includes the amount of power which has to be exerted to overcome the resistances of the various parts of the engine, and such accessories as compressor, cooling-water pumps, oil-pumps, etc. As this is a very variable quantity. it is a matter of uncertainty as to what proportion of the whole i. h. p. is available for useful work in driving the ship.

It is, therefore, generally recognized that in order to properly state the power of which an engine is capable, it should be in terms of horse-power available at the brake, or other point of absorption of that power.

For many years the Dynamometer has been found in the engineering laboratory only, except in a few instances, and while this has perhaps been partly due to the fact that terms of i. h. p. have been sufficient for commercial purposes, it has been due no less to the lack of a dynamometer capable of being easily operated, of extreme accuracy and of absorbing large powers. In recent years this lack has disappeared, but it would be well before describing the type of "brake" almost universally in use, for "high powers", to trace the progress which has been made in the subject generally.

It is clear that the crude implements which served in the past are futile things. Time, reliability, and accuracy are now all important. It must not, however, be forgotten that there are several brakes even in use to-day which have served and continue to serve certain purposes; for example, the Prony brake. which utilizes ropes and wooden blocks applied to a flywheel. In an improved form of this type of brake, the ropes and counterbalance weight originally used are dispensed with and replaced by an arrangement of thin steel straps and a spring balance. These straps are fitted with a large number of hard wood blocks placed about two inches apart, the blocks being generally made of the same width as the flywheel upon which they bear, and kept from slipping from one side or the other by a number of metal clips screwed on each side of them. On starting the engine, an adjusting nut is left quite slack until the desired speed has been attained. It is then gradually turned until the necessary "pull" is registered by the balance. The disadvantages of this system are that the resistance is apt to be jerky, rendering observed readings very unreliable, whilst constant attention and frequent application of a lubricant is necessary. Another serious objection is the unfair strain imposed upon the bearings of the engine, while if frequent stopping and re-starting is required the necessary adjustment to regulate the load is inconvenient. Apart from this, the capacity of such an arrangement is very limited.

One well-known form of friction-brake, which is fitted with a compensating device, is that designed by Mr. C. E. Amoc and Mr. Appold. This was the type used at one time for what were then considered to be large powers. It is similar to that described in the foregoing, but besides a hand-adjusting screw it is provided with a compensating lever, by means of which the rise or fall of the load is attended with a decrease or increase in tension on the brake-strap, so that a position of equilibrium may be automatically attained without causing inaccuracy in the readings. With a given tension in the brake-strap, and with the load carried so that its point of suspension is opposite a pointer mark, the lever takes a vertical position; but as soon as the load is lifted, the lever moves round to the left-hand, and virtually increases the length of the brake-strap, and thus slackens it, allowing the load again to descend. If, on the other hand, the total friction decreases and is insufficient to carry the load in its normal position, the descending load presses round the point of the compensating lever to the right, thus tightening the strap and increasing the frictional grip until the conditions are again such as will enable the lever to reassume a vertical position. If the change in the position of the point of suspension of the load has been due to a temporary cause, this automatic action may restore the balance without further adjustment; but if the departure from the normal position be considerable, then adjustment by the hand-screw

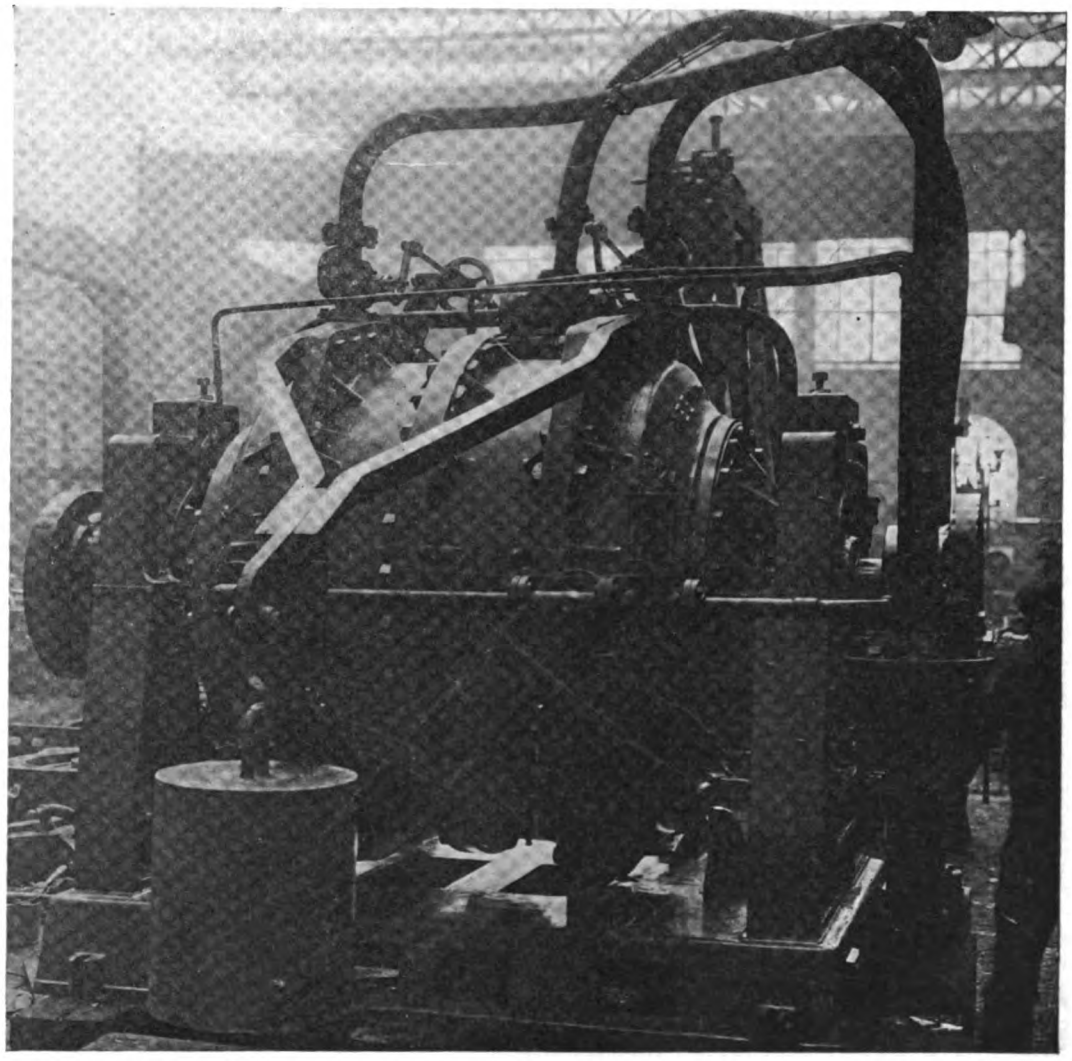

Fig. 2. A double rotor reversible hydraulic dynamometer supplied to Carels Freres. This brake will absorb 2500 b.h.p. at 180 to 250 r.p.m.

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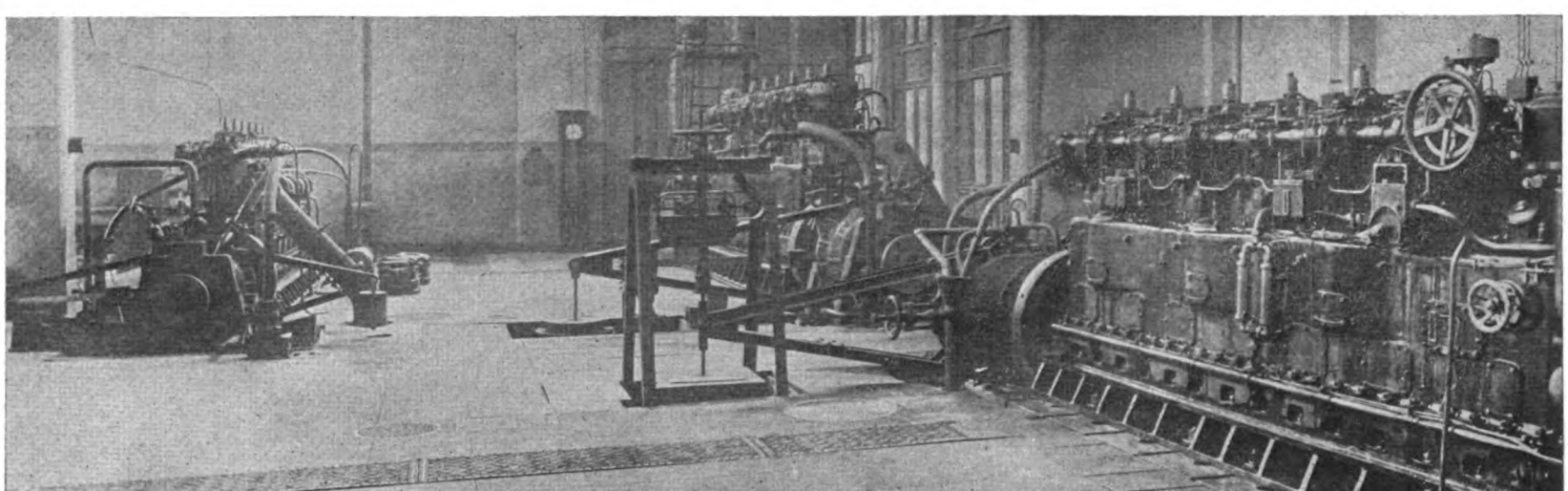

Fig. 3. Diesel engines being tested by means of dynamometers at the testing shop of the Ansaldo-San Giorgio (Ex-Fiat San Giorgio) Turin, Italy.

must be resorted to. It will be seen that the compensating action cannot come into play except by the rise or fall of the weight from its proper position, and hence the value of the device is confined to its power of limiting that rise and fall.

As long as the Appold brake is not used for more than about 15 b. h. p. and is properly lubricated with tallow or suet, the friction between the wooden blocks and iron wheel is sufficient at ordinary speeds to balance the load without tightening the belt-strap. Under these conditions, the compensating lever does not sensibly affect the results, since the pull on it will not be more than a few pounds. The conditions are the same as, or very similar to, those which would obtain if the brake were without a compensating lever, but with a strap so slack that the bottom blocks barely touch the wheel.

Professor A. B. W. Kennedy in his paper on the "Use and Equipment of Engineering Laboratories" says, that if the Appold pendulum-lever is used in any form for the automatic adjustment of the brake, it should be so arranged that its own pressure can be measured and allowed for, thus indicating that this is always an element of inaccuracy in the results obtained.

The results obtained by electrical brakes are always open to argument on account of the efficiency factor of the dynamo, while the correctness of the ammeter and the volt-meter also enters into consideration. Unfortunately, the resistance cannot be maintained absolutely constant over a long run on account of the variations in the current produced, due to changes of temperature of the dynamo, and also on account of the difficulty in maintaining the resistance in the external circuit constant.

For small powers, the dynamo is sometimes mounted bodily on anti-friction bearings, and the torque between the armature and the field coils measured by means of an extended arm and spring balance. Obviously, this method of application is limited to comparatively small powers. Here again, there is trouble in maintaining the load constant, and the range of speed and power which can be obtained from such a device is limited.

For high speed work, the momentum of the rotating parts of the apparatus is considerable, and cases have been known where, through slight trouble occurring with the bearings of the engine under test (causing the engine to slow down), the momentum stored up in the armature of the brake has been sufficient to snap the engine crank-shaft.

Fan-brakes are sometimes used for small powers and high speeds. In a few cases large open running fans have been used for as much as 150 b. h. p., but the brake for this duty is exceedingly large and unwieldy—particularly with a slow speed engine—and also is dangerous. The apparatus consists of two or more arms fixed on the shaft of the engine to be tested. A rectangular piece of thin steel plate is fixed to each of these arms and the power is absorbed in forcing these plates at a high speed through the air. The power is regulated by varying the distance of the steel plates from the engine shaft.

These brakes are calibrated by running a fan on a standard engine, and a series of curves is supplied with each fan from which, knowing the speed at which the fan is running; the size of the plates used; and their position on the brake arms, the power absorbed may be ascertained. Users of such brakes have, therefore, to rely absolutely on the accuracy of the curves supplied by the makers. It is true, these brakes are very simple, cost very little, and for rough and ready testing answer fairly well, but there are a number of objections to their use, the most serious being, of course, the question of accuracy in the results obtained. Naturally, the resistance of such a fan will vary considerably with the different positions of the steel plates in relation to external surroundings. If the fan is run in a large open space, so that it would be able to churn up an unlimited quantity of air, it will give a different result to that which would obtain were it running in a small room, where the flow of air would be interrupted to a great extent by surrounding objects. Or if the lower portion of the fan worked in a pit, as is often necessary on account of size, the result would be inaccurate. The resistance also varies with atmospheric conditions.

A further, and considerable source of trouble, is the great noise which these fans make. When an engine is on test it is highly important that the brake should make no noise, in order that any trouble developing in the engine may be detected. Moreover, fan brakes create a great deal of draught in the test house, and cause very unpleasant and dangerous conditions for those in charge.

Of course, some of the above objections may be overcome by enclosing the fan in a suitable casing and by other means, but even then the results obtained are unreliable and at best only comparative, the standard for comparison being the original engine on which the fan was calibrated.

Of the many devices employed in this most interesting branch of scientific engineering, there is probably no instrument that has achieved for its inventor such well-merited distinction as the Froude water dynamometer. It is an interesting fact, and one which may not be generally known, that Professor Osborn Reynolds, of the Victoria University, used a brake of this description when investigating the correct value of the mechanical or "Joules" equivalent of heat in foot pounds, and the figure now universally accepted—778 ft. lbs.—1 B. T. U., was established by this test. This is interesting as a proof of the scientific accuracy of the Froude brake—the range of temperature from inlet to outlet, and the quantity of water used affording an exact measure of the power exerted.

More interesting, perhaps, to the readers of "Motorship" will be the fact that the Froude dynamometer was originally designed by the late Mr. William Froude, and was used by him in his experiments on the propulsion of ships.

From the sectional drawing of the "Froude" dynamometer (which, by the way, is manufactured by Messrs. Heenan & Froude Ltd., of Worcester, England), it will be seen that the device consists essentially of a rotor carried on a shaft and running in a casing. The shaft is carried by bearings fixed in the casing, not in separate supports, while the casing, in turn, is carried by anti-friction trunnions, so that it is free to swivel about the same axis as the main shaft. When on test, the engine is directly coupled to the main shaft, transmitting the power to the rotor revolving inside the casing, through which water is circulated to provide the hydraulic resistance and simultaneously to carry away the heat developed by destruction of power.

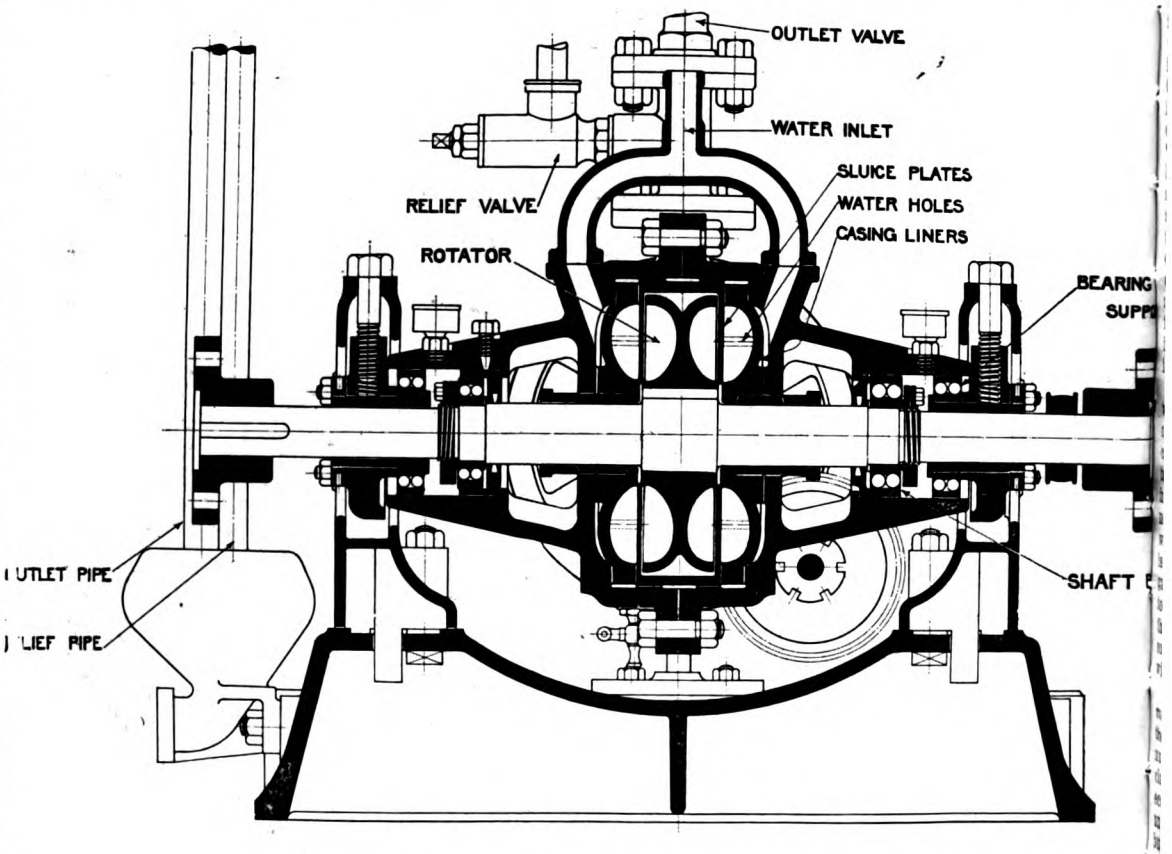

Fig. 4. CROSS SECTIONAL ARRANGEMENT THRO' D.P. TYPE DYNAMOMETER.

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In each face of the rotor are formed pockets or cups of semi-elliptical cross section divided one from another by means of oblique vanes. The internal faces of the casing are also arranged with a corresponding number of pockets.

When in action, water is supplied to the pockets by means of holes drilled in the vanes. The water is then discharged by the revolution of the rotor into the pockets formed in the casing and a vortex action set up—a film of water being constantly circulated round each elliptical space formed by the coming together of pockets in rotor and casing.

The resistance offered by the water to motion of the rotor re-acts upon the casing, which tends to turn on its anti-friction roller supports. This tendency is counteracted by means of a lever arm terminating in a weighing device consisting of either a spring balance or simple scale pan on which weights may be placed.

From the description of the foregoing, it will be seen that the forces resisting rotation of the Dynamometer shaft may be divided into three main classes:—

(a) The hydraulic resistance created by the Rotor.

(b) The friction of the shaft bearings, which are usually of the roller type.

(c) The friction of the glands.

It will be noticed that every one of these re-acts upon the casing, which being free to swivel upon anti-friction trunnions transmits the whole of the forces to the weighing apparatus. Thus, every force resisting rotation of the engine shaft is caused to re-act upon the weighing apparatus, ensuring absolute and scientific accuracy.

It has been said that hydraulic brakes in general are unreliable, and that this accuracy is affected by variations in the clearance allowed between the faces of rotor and casing. A moment's consideration will show that this contention is erroneous. It is, of course, quite obvious that the "capacity" to absorb power of such a brake will depend to some extent on the amount of clearance allowed, but the accuracy with which the power absorbed may be determined will not be affected in any way. Or, stated another way, greater clearance would necessitate the use of a larger machine to absorb the same power.

In the case of low duty machines, the rotor is made of cast iron, while for high duty machines it is of cast steel, and the instrument is designed both as a reversible and non-reversible dynamometer, the former by the construction of a double rotor.

All Froude dynamometers have lever arms of such a length that the power absorbed under test can be very easily calculated by means of a simple formula—This is as follows:—

$$\text{B.H.P.} = \frac{W \times N}{K}$$

Where W=load at end of Dynamometer arm
N=revolutions per minute
K=constant.

For example, in the case of a machine built to British standards, having an arm 5 ft. 3-1/40 in. long—K=1000. For a metric machine, having an arm 1432.4 m.m. long K=500.

Reports from users of this type seem to confirm the claims of the makers of the Froude dynamometer in regard to the following points:—

(1) Scientific accuracy.
(2) The resistance is hydraulic, so that at starting it is practically negligible, but rises rapidly with speed.
(3) Great range of capacity.
(4) The inertia of the rotor is very slight.
(5) Silence in operation.
(6) The load can be altered at will while running.
(7) The load can be shut down quickly without exertion.
(8) Suitability for very long non-stop running at full load.
(9) The Dynamometer exerts a pure troque resistance and imposes no load on the engine bearings.

In the various sizes of brakes turned out by the makers, the adjustment may be regulated from full power to one-fourteenth of this amount, and when it is said that machines capable of absorbing up to 4000 B. H. P. at 70 R. P. M. are standardized, an idea of the range afforded by each standard brake will be obtained. This brake, therefore, places in the hands of both mechanical and electrical engineers a means of measuring the power developed by prime movers up to very large sizes. [In our tour through Europe we found that with very few exceptions this dynamometer had been adopted as standard by all heavy oil engine builders. Many American companies also test all their marine oil engines with it.—Editor.]

Motorships Versus the High Cost of Oil and Coal

A Frank Talk by the London "Engineer" for the Digestion of Shipowners

[*Of all public publications least given to idle chatter is "The Engineer" of London, which publication has won universal recognition for its seriousness on engineering matters, with the result that it is to be found in the offices of practically every important American engineering shipbuilding plant. Therefore, its viewpoint on the motorship question will be of very considerable interest, so we republish the most vital parts of its editorial-leader for November* 14, 1919, *as follows:—Editor, "Motorship."*]

One of the factors which contributes to high freights is the high cost of fuel, bunker coal bequoted at 111s. per ton in London. Motorships do not require to use that high-priced coal. Why, then, it may fairly be inquired, is it that every shop which is capable of building a marine Diesel engine is not crammed with work of that nature? * * * * *

We are not for a moment forgetting that we have in the past been most earnest in our plea for caution in the installation of the Diesel engine without thorough trial, lest its future should be imperilled by one or two serious failures. * * * * * Conditions are now so different that we are almost inclined to say that it is better to install a practically untried Diesel engine than to do nothing. * * * * * Bearing in mind the pre-war comparisons between the cost of running steamships and motor ships, it might appear that in the present circumstances the economy to be obtained by the use of the latter would now be so enormous that there could be no hesitation on the part of the shipowner, and that, instead of absolute—or rather relatively absolute—reliability having to be placed first when considering the type of machinery to be installed, fuel costs would have the preponderating influence.

Unfortunately, the case is not so simple, and while it is only to be expected that the price of oil would have gone up to meet the increased cost of production, an amount by no means equal to that of coal, we have been astonished to learn in the course of our investigations that coal does not necessarily leave its rival behind in this ratio when its price is raised. Indeed, the price of oil is also put up in sympathy without the least regard to its cost, just, so it is ingenuously stated, to prevent too great a demand for that fuel on the part of ships which can use either oil or coal. With fuel oil, Diesel engine oil rises too without any corresponding explanation. * * * * *

Yet, in spite of all this, there is still a large margin in favor of the motorship, even omitting the increased carrying capacity and the smaller number of hands required as compared with some classes of steamships. It is difficult to put the economy into concrete figures which would be universally accepted as applicable in all cases, but we propose to give an hypothetical instance in which the principal factors are absolute, but which can be modified to suit the requirements of any specific case.

The prices of bunker coal at various ports on a certain date were:—London, 111s. per ton; Cardiff, 65s.; Tyne, 62s. 6d.; Port Said, 156s.; Suez, 166s.; Bombay, native coal, 54s. In making our calculations we propose to ignore the London figure of 111s. per ton and assume that our ship could bunker on the Tyne, that is, at the lowest rate, and that she would call for bunkers only at Port Said on the way out to Bombay. Here she would pick up native coal and call again at Port Said on her return voyage. Thus, as will be seen, we take only the lowest figures and they would give us 62s. 6d., 156s., 54s., and 156s., or an average price of 107s. per ton for the round voyage.

Diesel-engine oil at the same date was something over 143s. per ton—say, 150s.—and this price, owing, we believe, to what are purely temporary causes, is the same either in London or out East, and can be taken as for the round voyage wherever she bunkers. We will further assume our ship to carry 8,000 tons of cargo out and home; that her engines, whether steam or internal-combustion, are of 3,000 indicated horse-power, and that she spends sixty days actually at sea. A very reasonable figure for coal consumption for the steamship would be 1.3 lb. per indicated horse-power per hour, and for oil consumption 0.35 lb. per indicated horse-power per hour. Both these figures are purposely taken as most favorable to the steamship, especially in view of the native coal to be used on part of the voyage. On these assumptions the total fuel cost would work out at £13,400 for the coal and £5,060 for the oil, **a difference of £8,340 in favor of the motorship.** This saving, when applied to the 16,000 tons of cargo carried on the round voyage, represents more than 10s. per ton, quite apart, as we say, from any other savings.

Surely the shipowner must see that with the terrific prices he has to pay for his ships, there is here something that will help him, and if he will even only share the saving equally with the consumer, while helping him, will really help to bring down the cost of living. **Really serious troubles with the Diesel engine are no longer to be feared,** and it is only comparatively minor difficulties which need be anticipated today, and the sooner they are faced the sooner they will be overcome. Experience will have to be bought, and the sooner the shipowner and engine builder combine to buy it the better.

There are other reasons why the shipowner may take up with some confidence the installation of the Diesel engine in his new ships. * * * One of our largest and most farsighted shipowners has a big works engaged in building Diesel engines, we believe, exclusively for him; while another who runs the former close in foresight is following on his heels in practice.

Other firms who have had long experience with motorships are adding to their fleets. A striking commentary on these facts is that we have requested several of these firms to favor us with details of the performance of their ships, in order that we might place before shipowners generally some definite facts as to how long it takes to "turn round" a motorship and the nature and extent of the overhauls required at the end of a voyage, and of the troubles, if any, experienced *en route*. **Not one of these firms is apparently willing to say a word** on such an extraordinarily interesting subject. Why not? **Is not the obvious inference at this date that the motorships are giving them such good results that they do not wish their rivals to know how good they are,** and so invite them to invade their preserves? We shall assume it to be so until we are definitely informed on good authority that such is not the case.

[*In making this comparison, "The Engineer" has not taken into consideration the fact that because of their economical consumption* 600 *tons of bunker-oil will be sufficient to take a* 10,000 *tons d.w.* 11-*knot motorship about* 15,000 *sea-miles. Thus she can pick up fuel where it is cheap and so not pay more than* $14.00 *per ton instead of the British price of* $40.00. *So the operating costs are far more in favor of the motorship than outlined by "The Engineer."—Editor, "Motorship."*]

MOTORSHIPS OF 16,000 TONS D.W.C. AND 15 KNOTS SPEED UNDER SERIOUS CONSIDERATION

We have previously referred to the 14-knot 13,000 tons d.w.c. motorships now under construction for the East Asiatic Co. of Copenhagen, which will form part of their fleet of 29 large modern Diesel-driven vessels in service or on order. This company is now working on plans for 15-knot cargo-passenger motorships of 15,000 to 16,000 tons d.w.c. and of 8,000 I.H.P. in twin-screws. As soon as the new 13,000 ton vessels have made successful voyages the above larger craft will be laid down. The fuel-consumption of the 16,000 ton ships will not exceed 26 tons (182 barrels) per day, and they will carry at least 2,000 tons more net cargo than an oil-fired steamer of the same speed and capacity.

FAST PASSENGER MOTORSHIPS FOR COASTWISE SERVICES

As there are a number of 3,000 shaft h.p. German four-cycle type Diesel engines of moderate speed and light weight available, we suggest that they could be well utilized by American, British or French shipowners for fast fine-lined passenger ships for coastwise and cross-channel services, where not more than five or six days' continuous operation of the main engines would be required. Three such engines in a ship would give an equivalent of 11,000 steam i.h.p., or sufficient to drive a moderate size craft of this type at about 19 or 20 knots, either direct or through electric transmission. Owing to the small machinery space required and the very low fuel-consumption, such boats would be exceedingly economical to operate. As the engines are idle they may as well be turned into practical use.

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Our Readers' Opinions

[The Publication of Letters does not imply Editorial Endorsement of Opinions Expressed—EDITOR.]

VIEWS OF A PROMINENT BANKER

To the Editor of "Motorship",
Sir:

I have read with interest your editorial in "MOTORSHIP" for November, 1919. You could hardly ask for any better endorsement of your position than was recently supplied by Secretary of the Interior, Franklin K. Lane, who in his report for the last fiscal year, advocated that internal-combustion engines be utilized in connection with the Government shipbuilding program rather than that oil be burned under boilers to provide steam motive-power.

Very truly yours,
A. M. HARRIS.

Harris, Forbes & Co.,
New York City.

THE QUESTION OF WAGES OF CREWS

To the Editor of "Motorship",
Sir:—

For a considerable time past extensive publicity has been given in the daily and shipping papers regarding the high-cost of wages of the crews of American ships and the number of men carried compared with similar foreign vessels. One of your contemporaries has gone to considerable time and trouble in obtaining figures in connection with the wage-bills of the crews of 7,500 tons d.w. steam-driven cargo-vessels. The monthly wage-bill is given as follows:

American Ship	British Ship	Norwegian Ship
$5,465.00	$3,687.50	$4,270.75

This gives a difference between the
American Ship and British Ship of $1,777.50
American Ship and Norwegian Ship of $1,194.25

Shipowners have spent many hours of valuable time in sessions, in interviews, and in writing letters to their Congressmen and to the daily papers over this matter with a view to producing legislation that will more equalize operating conditions.

Yet by some strange and unexplainable reason the majority of American shipowners, as you say, are "too busy" to inspect a type of vessel—when they arrive in our harbors—that have larger earning capacities than steamers by anything from $50,000.00 to $250,000.00 per annum according to the size of ship and the trade route. Of course, many of our shipping laws need revision, but why not let us first effect the big economies?

You have frequently stated that shipowners are always "too busy" to visit these fine motorships which foreigners send to our free harbors and carry-away American manufactures that should be shipped in bottoms owned and operated in the good old U. S. A. It costs nothing for a shipowner to see for himself!

Will some leading American shipowner oblige by writing to your paper and enlighten?

Yours very truly,
Boston, Mass. ANDREAS COLEMAN.

THE ENGINEER QUESTION

To the Editor of "Motorship",
Sir:

Regarding Mr. Schreck's letter in a recent issue, in regard to the matter of engine room crews for motorships. I think you will find that there is a strong prejudice on the part of many steam engineers, especially the older and more matured men, against taking up the newer type of machinery. Many will dislike to take up the new type of machinery, and make the careful study which its successful management will require. Some of course, and these the most progressive, will go to it eagerly, but it seems to me that there is another class of engineers, already somewhat familiar with the subject, from whom the majority of the future motorship engineers will be drawn.

I refer to the petty-officers of the Navy, those who have been in the submarine service and who have already acquired a certain knowledge of this type of machinery, and who, with this experience, and papers, and a little shop-training, would welcome the advance in pay, which such a position would offer.

The requirements for engineers on motor-vessels are not as well defined as they might be, and the securing of a license by one who has served several years in the engine-room of a submarine should be easier than for an engineer accustomed only to steam vessels.

Yours very truly,
MORRIS M. WHITAKER.

Nyack-on-Hudson,
New York.

WHY MESSRS. ————'S AUXILIARY SHIPS WERE NOT VERY SATISFACTORY—OWNERS—NOT ENGINES—TO BLAME FOR POOR RESULTS

To the Editor of "Motorship",
Sir:

We would state that we have duly received the copy of the November "MOTORSHIP" for which we thank you. Our previous experience with nine motorvessels has not been very encouraging.

Yours very truly,
———— and Co.

————., New York City.

[Owing to the sad death of one of the principals of the firm who wrote the above letter we have withheld their name and address, but publish our reply for the benefit of other shipowners.

We think we are correct in saying that these particular vessels were wartime-built wooden sailing-ships fitted with auxiliary motors. Let us state that the majority of these vessels built in the United States during the last three years were failures before they commenced construction, as they do not carry sufficient canvas to sail without power, nor is the power sufficient without the sails. Yet, in most cases the captains and owners try and operate these ships as full-powered vessels.

Consequently, the ship's oil-engines are overloaded and suffer frequent break-downs. To quote a similar case, while the Ford engine is a very excellent machine, it would not operate satisfactorily if you put it in a heavy Packard chassis and tried to drive it up-hill at full-speed continuously.

"MOTORSHIP" is constantly advocating against the underpowering of these auxiliary vessels and the entire question of auxiliary-ships was very thoroughly gone into in our issue of September, 1918. Furthermore, we raised the question of the proper amount of power for such craft in our paper before the Society of Automotive Engineers.

If you will refer to Mr. Schreck's letter on page 62 of our November issue, you will see that these auxiliary-vessels, and small American full-powered motorships, carry the least experienced and youngest men as engineers, the best engineers going to larger steamships because of the higher pay. This, also is derogatory to reliable operation.

Therefore, it is a pity if you have placed your ideas of motorships on such craft. If you have been advised that modern Diesel-driven motorships are unreliable, let us emphasize the fact that you have been misinformed—as the majority of European full-powered Diesel-engined ships now in service have smaller repair bills than the average steamer, as also have many smaller American motorships. —Editor.]

DEATH OF PROMINENT MOTORSHIP BUILDER

To the Editor of "Motorship",
Sir:

One of Burmeister and Wain's directors, Mr. Martin Dessau, financial director and counsellor of state, died in October.

Mr. Martin Dessau was financial-director at the Burmeister and Wain's Diesel Engine Works of Copenhagen, Denmark, from 1897, and was 54 years old. To a great extent it was Mr. Martin Dessau's foresight which gave rise to erecting of the big Diesel-engine construction plant. It was Mr. Martin Dessau who during a trial trip on board the Danish 10,000 tons Motorship "Christian X", on June 25th, 1912, sold this ship direct to Germany's (at that time) greatest shipowner, Herr Albert Ballin.

Very truly yours,
Seattle, Washington. ALFRED GALL.

SUBSCRIBERS' CHANGE OF ADDRESS

We have received numerous letters from our subscribers advising us that they do not receive their copies of "Motorship." The Management has made a thorough investigation of these cases and finds that in the majority of them the subscriber has omitted to inform us of a change of adress in due time so that "Motorship" could be sent to the new address. Unless unforeseen circumstances prevent—the copies of "Motorship" are placed in the mail on the 25th day of the month preceding the date of issue.

What Naval Officers Say

NO SMOKE WITHOUT FIRE

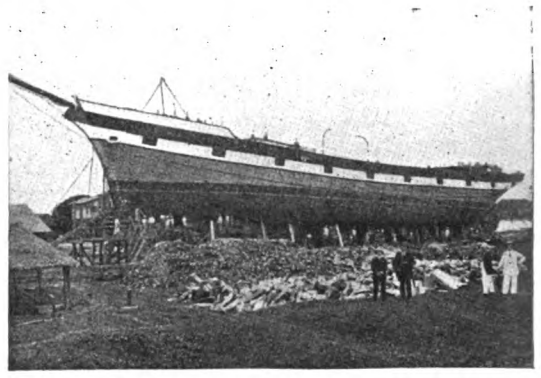
Readers of "Motorship" during the late war will remember how we urged the use of Diesel engines for freighters, tankers and submarine chasers. Admiral Lord Fisher, in his recent articles to the London "Times" advocating motorships, went one stronger than we did, for he feelingly said: **"You can see the damned smoke forty miles away."**

ANOTHER ADMIRAL ADVOCATES MOTORSHIPS

Recently Rear-Admiral Sir W. Nicholson, Controller of the British Navy, told the Institute of Mechanical Engineers that—"In the Navy we cannot stand the weight that mercantile ships can. But, I am convinced that the internal-combustion engine is the engine of the future, be it for a warship or a mercantile ship.

COMMANDER W. LEDYARD CATHCART, U. S. N., R. F., AND DIESEL ENGINED MOTORSHIP

In an interesting article in the New York Herald for December 21st, 1919, Commander Wm. Ledyard Cathcart, U. S. N., R. F., says: "The Diesel engine in its present stage of progress stands today an accomplished fact, a proved path to the solution of national problems of most momentous character—the conservation of our fast dwindling fuel supply, cheaper transportation, and incidentally, the existence against foreign competition of our new-born American merchant marine.



Burmese oil-engined auxiliary barquentine "Armenia"

WOODEN MOTORSHIP CONSTRUCTION IN BURMAH

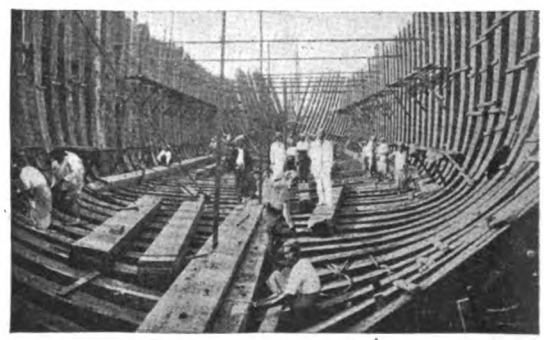
For the last couple of years wooden auxiliary motorship construction has been very active in Burmah, so this field should prove a very attractive market for American oil-engine manufacturers if properly handled, as about 24 vessels ranging from 150 ft. to 200 ft. length are completed or under construction.

The largest ships are two auxiliary-barkentines nearing completion at the yard of A. C. Martin at Rangoon. These vessels have the following dimensions:

Length O. A.	230′ 0″
Length B. P.	200′ 0″
Breadth	38′ 0″
Depth	18′ 6″
Power	200 B.H.P.

In both vessels a 200 b.h.p. heavy-oil engine is being installed, and the ships are classed at Lloyds and by the British Corporation.

At the yard of the Bombay Burmah Trading Corporation, Maulmain, Burmah, a 136½ ft. by 30 ft. by 16 ft. bark is being built, while MacGregor & Co. are building a 500 tons d.w. schooner. Also many native companies are building vessels of 200 to 500 tons d.w.c. For this information and illustration we are indebted to the "Shipbuilder" of England.



Wooden auxiliary sailing-ship under construction at A. C. Martin's yard, Rangoon, Burmah

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Diesel Ship is Type of Vessel Most Nearly Fulfilling Conditions Required to Produce Low Transportation Costs —Says Mr. Geo. J. Baldwin

President of Pacific Mail Steamship Company Staunch Believer in Motorships for America's Merchant Marine

(Special to "MOTORSHIP")

[The views of Mr. Baldwin necessarily will carry great weight with American Steamship Owners and Operators. The Pacific Mail Steamship Company is one of the most important shipowning concerns in this country. Furthermore, it is allied with such important organizations as the American International Corporation, New York Shipbuilding Corporation, W. R. Grace & Co., etc. We give the prominence due to Mr. Baldwin's sound conception of the value of the type of cargo-carrier that will keep our Merchant Marine on the High Seas. He is one of the limited number of American shipowners who have gained information knowledge through personal visits to the European motorships that call at our ports and so his knowledge has been gained first-hand.—EDITOR.]

THE subject of the Diesel motor-driven ship is of very great interest to all builders and operators of ships—Experience up to the present time has assured us of the permanence of the motor-driven ship as a most useful type. The preliminary difficulties have been overcome and we have arrived at a period where the improvement and refinement of the engine itself and its auxiliaries as well are our principal problems. We can now expect with considerable confidence that for all long-distance voyages of the cargo-carrying vessel up to 10,000 or 15,000 tons capacity and speeds as high as 14 knots, Diesel-driven ships may eventually largely replace steam-driven vessels. Even on shorter routes the Diesel-driven boat may ultimately force out the steam drive on account of its proven greater economy both as to fuel and crew, to say nothing of the somewhat greater cargo-capacity of the Diesel boat.

Two of the principal factors which may accelerate this tendency are the permanently increased costs of coal in all of the coal-producing countries of the world and the greatly increased production of fuel-oil in the known oil-fields as well as the discovery of many new ones. Coal is becoming of more value for land use on account of its increasing distillation in by-product coke ovens which yield by-products of great value in the arts and sciences. Oil is increasing in its relative value for use at sea on account of its very much smaller bulk compared with coal of the same thermal value and its adaptability for use in internal-combustion engines, permitting considerable savings of both cargo and bunker space as well as a smaller engine-room force.

MR. GEO. J. BALDWIN
President, Pacific Mail Steamship Company

Another factor of importance is that while the cost of producing coal may reasonably be expected to increase as time progresses, the same condition need not apply to oil on account of the smaller proportion of its cost due to the element of labor. The result will be an increasing use of oil for sea use and emphasizes the importance of Diesel-driven ships.

The present trend of improvement in Diesel practice is toward the utilization of the lower grades of oil and the elimination of compressed-air for its injection into the cylinders, both of these affording a very material economy, and when they are perfected the future of the internal-combustion engine would seem to be permanently fixed.

There is a universal demand today for better accommodations on board ship for officers and seamen, which is being supplied in practically all of our newer vessels, and in consequence we are now in a position to draw upon the best material we have for officers, engine-room crew and seamen. This means higher wages, but not necessarily higher cost of operation, as the increased wages will be more or less balanced by better efficiency, particularly if we perfect a more economical and effective type of vessel to take care of our present high construction-costs, as we must do in order to maintain the lowest possible transportation-cost per ton mile.

We can therefore readily see many different causes in favor of an increasing use of the Diesel-driven boat, which seems to be the type of vessel most nearly fulfilling the conditions required to produce low transportation-costs on long-distance voyages.

Geo J Baldwin

Launch of 10,500 Tons Motorship for Standard Oil Subsidiary

The 3,000 I.H.P. Vickers-Diesel Engined Tanker "Narragansett" Launched at Barrow—Sister Motorship Building at Same Yard—American Shipbuilders, Wake-up!

WHILE most of our shipbuilders are lethargic over the motorship question an enterprising British firm takes advantage of their slumber by walking-off with orders for a couple of large full-powered steel motorships under their very noses, as it were. At the end of November, Vickers, Ltd., of Marrow-in-Furness, England, launched the first of two sister "Diesel" engined 10,500 tons d.w.c. tankers building to the order of the Anglo-American Oil Co.,—a subsidiary of the Standard Oil Company.

The first vessel has been named "Narragansett", replacing the steamship of that name, lost during the War. Two Vickers solid injection type "Diesel" oil-engines of 1,250 shaft H.P. (1,500-1550 I.H.P.) each are being installed, and due to the absence of air-compressors for fuel-injection they will have a mechanical-efficiency of about 80 per cent., and what is even more noteworthy, will have a fuel consumption of 0.38 lb. per shaft horse-power (0.28 lb. per I.H.P.) compared with 1.15 lb. per shaft horse-power (0.98 lb. per I.H.P.) for the most economical oil-fired geared turbine drive.

The ms. "Narragansett" has the following dimensions:

Displacement	14,000 tons
Dead-Weight Capacity	10,500 tons
Bunker Capacity	733 tons
Net Cargo-Capacity	9,750 tons
Length	425 ft.
Breadth	56 ft.

Normally the vessel will carry 9,420 tons of oil-cargo and 510 tons of bunker-oil.

Sir James McKechnie, the Managing-Director of Vickers, Ltd., at the luncheon following the launch stated that on a voyage from England to India this ship will be able to carry her cargo at 10 shillings and 5 pence per ton lower than a steamer of the same tonnage and speed, without taking into account the additional and larger gain to be effected from the greater cargo-capacity afforded by the absence of boilers, boiler-water, and stand-by charges, and by the reduced bunkers; also that after spending $560,000.00 on 15 years Diesel-engine research, his firm is convinced of the success of the oil-engine. Incidentally the amount spent should suggest to American shipbuilders that it is more economical to purchase a license for a successful motor than to develope a new design.

(*Continued on page 44*)

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Scandinavian Motor-Coasters and North Sea Traders

Standard Danish 600 H.P. Diesel and Surface-Ignition Engined Auxiliaries

IN the Scandinavian countries the motor auxiliary has found universal favor for off shore trading and fishing. For these purposes the type as developed has been a pronounced success, and in most of the vessels the motors are operated continuously. Their sails are used when the opportunity offers but the ships are not operated as auxiliary-schooners in the usual meaning of the term. Credit must be given to the Norwegian and Swedish ship-owners for the pioneer work in this rapid development, but at the present time the greatest activity in turning out the new craft is to be found in Denmark. In that country a standard "slet-topped" four-masted schooner is in great favor and was developed previous to the outbreak of the war in 1914.

The first vessel of the new type was laid up for a while after completion as the owner did not think the rise in wages and insurance would permit any profits. Finally a profitable trip was made with mine props as a cargo from Sweden to Granton in England and the result was that repeat orders have been placed for similar vessels by the same owner. So successful has this type been that most of the Danish provincial yards have become engaged in building sizes from 500 to 600 tons d. w. The construction is of wood except in those built at the Svendborg Yard where the original vessel of this type was constructed.

It must be remembered that war time difficulties have limited the output of all yards, the restrictions being for some time almost prohibitive for shipbuilding. The confidence placed in this type of motor schooner is well founded, not only on account of the greater yearly transport capacity over that of the sailing vessel, but also due to the great economy effected in doing away with tug fees in entering and leaving harbors. The motor-auxiliary also enjoys equal privileges with the steamer in being granted priority in going to quay for unloading and loading. This is because such vessels can be equipped with motor-winches for handling cargoes.

Perhaps the most interesting point about the development of the 600-ton auxiliary is the competition between the Diesel engine and the hot-bulb motor. About 160 b. h. p. is the usual amount of power installed. The engines generally placed in these vessels are either the Holeby four-cycle Diesel-engine with reverse gear or the Tuxham surface-ignition motor. Kalundborg-Junkers-Diesel motors have been placed in the wooden vessels at the Norwegian Ancas yard, while in the twin-screw installation two 90 h. p. Alpha four-cycle hot-bulb motors are used. In addition to the vessels of the size mentioned, quite a number have been and are being built, which are both larger and smaller.

Regarding Diesel-engined steel vessels built at the Svendborg yard, the Diesel engine extends two frame spaces further aft than would a two-cylinder surface-ignition engine and this space represents a cargo carrying capacity of about 6 tons. The installation is carried out to a Bureau Veritas special survey. When running at 240 r.p.m. the four-cylinder Holeby main motor develops 160 b.h.p. and drives the propeller through a reverse gear. A four-cycle 6 h.p. paraffin motor of the same make drives an auxiliary compressor through a friction clutch. On the port side are two air starting tanks and the injection air tank is mounted against the bulkhead. Mounted on one of the cylinders within reach of the engineer when standing on the operating platform is the main stop valve in the starting air piping. Cooling water pumps are bolted to the front end of the engine frame and are driven from an extension of the crankshaft. The piping of the two pumps is arranged so that the bilge pump can act as cooling water pump and vice versa. In this system there are two valves connected to the sea, one in the cooling water pump suction and one in the discharge line of bilge pump.

By means of a belt and pully the paraffin motor can also drive the bilge pump which is in connection with the various compartments of the double bottom. A steel vessel has an advantage over a wooden craft in that water ballast tanks can be provided at low cost and ballast can be quickly taken in or pumped out, while a wooden ship wastes time and money in loading and unloading its ballast of sand or other material.

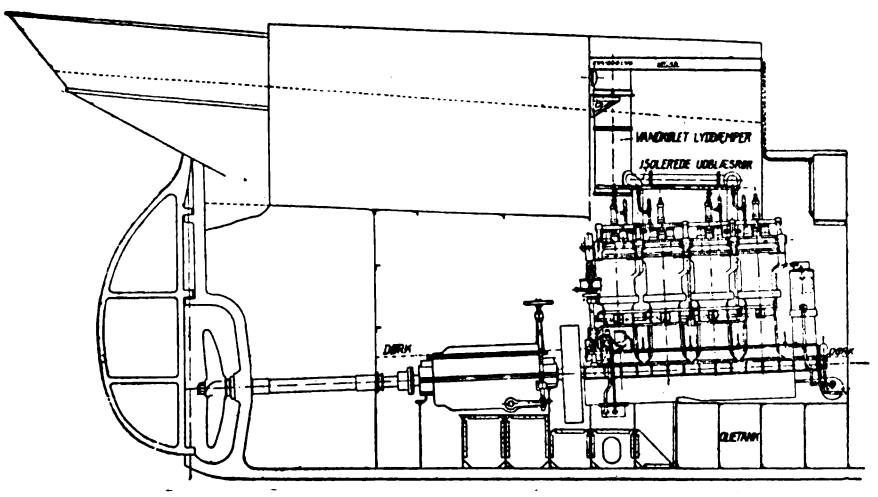
The double bottom fuel tank extends over 6 frame spaces and has capacity for about 8 tons. The fuel is pumped from the tank to a riveted sheet iron tank above mounted in a recess in the bulkhead by means of a centrifugal pump. This tank is divided into three compartments and has a capacity of about 650 k.g. (180) gals. oil and has a drain leading overboard. From this tank the fuel flows by gravity to a float tank with a filter and then to the fuel pumps. Both settling and filter tanks are provided with vent tubes, which unite into one pipe above the deck. On the end of this pipe a Davy's safety screen is fitted.

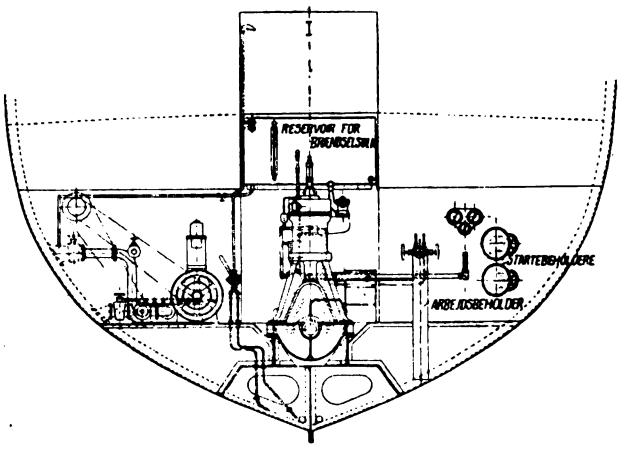
Cast iron pipes lead the exhaust from the four working cylinders to a water cooled silencer, which is mounted in one corner of the upper engine room casing. The exhaust from the 6 h.p. paraffin motor is also led to this silencer and is provided with a butterfly throttle which may be closed when the main engine is running and the smaller engine is stopped. Engine room ventilation is obtained by means of two air chutes. The reverse gear consists of two sets of conical wheels and two friction clutches, one for astern and one for ahead running, the gear being operated by means of a lever and hand wheel which disengages the propeller shaft from the engine when in the neutral position. If necessary the gear may be operated from above as the shaft on which the hand wheel is mounted is led above the deck. Cam wheels and clutches are completely enclosed in a castiron casing mounted in the gear box. Between the four-bladed propellor which has a diameter of 1,600 m.m. (5 ft. 3 in.) and the stern post, a Cedervall protective and lubricating stuffing box is inserted. An engine telegraph with answering indicators from the motor to the bridge is placed in the engine room. From the low pressure receiver of the compressor a pipe is led to a special tank for the air whistles.

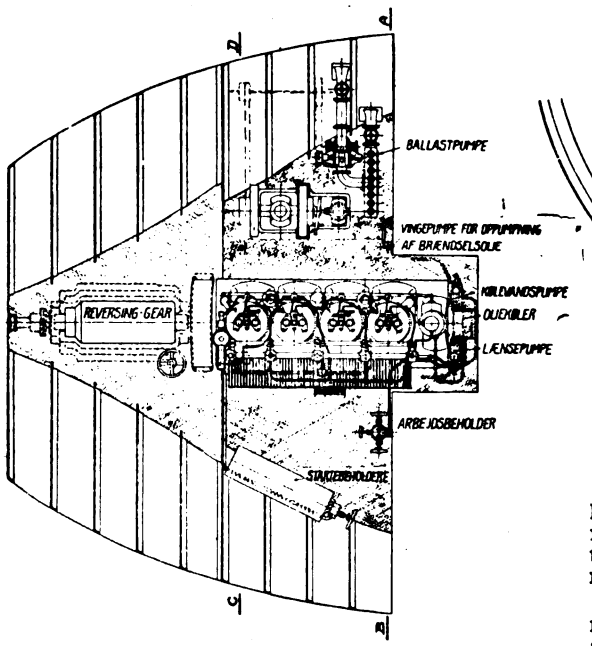
The four working cylinders of the main motors and the direct-given compressor are all bolted to a common castiron frame. All main bearings and crank pins are provided with forced lubrication. A small pump, driven by an eccentric from the vertical shaft of the motor draws the oil from a sump-tank in the base and pumps it through a filter and a radiator to a main pipe from which branch tubes lead to the main bearings. Owing to the forced feed lubrication, splash plates are provided between the cylinders and at the ends of the motor. Piston rings and pins of the working cylinders and the air compressor are lubricated by means of a Molerup gear driven from the horizontal manipulation shaft. Two fuel pumps are provided, one for each pair of cylinders and by means of distributing valves in the fuel lines the load can be equalized in all cylinders. The governor is provided with an apparatus for adjusting the number of revolutions between 150 and 240 per minute.

In a deckhouse is a 12 h.p. four-cycle paraffin motor which drives three cargo winches and the anchor windlass. These are connected to the motor by a chain and shaft drive; the shaft running fore and aft close to the hatch coamings as indicated in the deck plan. The main dimensions of the hull are: 132 ft. length between perpendiculars, 29 ft. 6 ins. breadth of beam, 11 ft. 3 ins. depth, displacement 805 tons, and dead weight capacity about 550 tons.

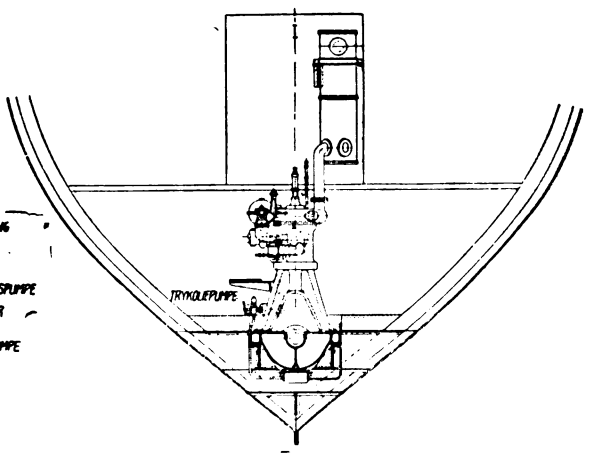
Aft over the engine room are the officers' quarters, where there are accommodations for the captains, two mates and the chief engineer. Forward are quarters for six men. The sail plan shows a rangement indicates a good able vessel with a long open cargo hold.







Engine-room plans of Norwegian-built 550 tons d.w.c. motor coaster fitted with 160 shaft h.p. Holeby Diesel oil-engine.



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Two-Hundred Million Francs for Oil-Engined Fishing-Vessels

Huge Construction Program Commenced by French Government—Opportunity for American Engine Builders—Subsidy on Imported Motors

By the Editor of "MOTORSHIP"

LET us hope that by this time marine oil-engine builders of this country have taken the necessary steps to secure orders for propelling and auxiliary power-plants in connection with the French Government's vast appropriations for heavy-oil engined fishing-vessels and for the merchant marine briefly outlined in our last issue. The most satisfactory plan is, of course, to establish agency relations with responsible companies in Paris or in the ship-building sections. As previously mentioned the sum of Fr. 200,000,000.00 is to be spent without delay for the reorganizing of France's sea-fishing industry, to construct boats and harbors, and to improve the equipment in general.

This is separate from the huge sum to be spent on the merchant marine. But, as regards the latter, it has been decided by the Ministry of Shipping not to place orders for completed cargo ships in the U. S. A. because of the adverse condition of the exchange-rate. However, as a subsidy is given on all French-built hulls powered with American (imported) heavy-oil internal-combustion engines, we estimate that American oil-engine builders have an excellent chance to receive orders for propelling and auxiliary machinery if rapid action be taken. This subsidy also applies to the fishing-vessels and holds good for nearly two years more, or—if the war is not "officially" over—for three years.

For the fishing fleet a harbor is being specially constructed at Lorient-Keroman, which will be one of the largest and best-managed in the world. During the war all the fishing-boats were requisitioned, either for hunting submarines or for carrying coal. Numbers of them were sunk, victims of many torpedoes, with the result that on the signing of the Armistice the fishing fleet, which was previously insufficient for France's needs, had reached as bad a position as the merchant fleet. Such a state of affairs could not be allowed to continue at the moment when the scarcity of domestic meat and the high cost of imported meats made it the Government's duty to encourage the French fishing-industry and to introduce in abundance the fish as a food to the country in general.

So far all the orders that have been placed for fishing-vessels have been for a combination of oil-motor and sailing-vessel, and practically no steam-driven craft are to be built. This has caused a great "hue and cry" by the steam-trawler builders, who have seized upon the fact that nothing has been done towards commencing some of the vessels ordered last spring. They urge that steam-trawlers are far more effective, but are careful to omit any reference to the great success of the full-powered Diesel-driven trawlers illustrated in our last issue. One of the strongest opponents of the auxiliary is a writer named Maurice Duval, who also says the auxiliary craft will cost 150,000 francs per boat. Yet, he admits that coal is scarce and high-priced to the extent of an intense crisis. Some of the new vessels will have seaworthy qualities which will permit of their crossing the Atlantic to the Newfoundland banks.

The following orders have been placed by the Under-Secretary of the Ministry for Merchant Marine:

Mons. Louis Bleriot's aeroplane works at Suresnes River Seine has received an order for **seventy** 75-ton Tuny fishing-vessels. Each will be propelled by a 100 shaft h.p. surface-ignition oil-engine giving an auxilary-power speed of 8 knots. The hulls will be of the Groix-type of wooden construction, and will have 240 sq. meters of sail over. Their length will be 20 m. 15 mm., o. a. by 16 m. at the water line, by 6 m. breadth and 3 m. 10 mm. draught. At this yard concrete-barges were built during the last months of the war.

At the West shipyard, St. Malo, at the St. Malo shipyard, St. Malo, and at the yard of the Naval Construction Co. of the South of France, at Martigues, a total of **forty** 250-ton herring smacks will be built and delivered by the end of 1921. Each will have a 100 shaft h.p. auxiliary oil-engine of the surface-ignition type.

One small steel trawler will be built by the Loire Shipbuilding Co., Nantes. She will be 24 m. 35 mm. long and will be fitted with a 70 h.p. oil-engine.

Two Sardine fishing-boats of 40 tons displacement will be built by the West Shipyard, St. Malo, and by the St. Malo Shipyard respectively. Both will have a 22 b.h.p. motor, and the hulls will be of wooden construction.

Forty tuny fishing-boats of 40 b.h.p. are to be divided among the following companies and completed by the end of 1920. They will be of wooden construction:

Paimpol & Fecamp Shipyard, Paimpol.

Naval Construction Co. of the South of France, Martigues.

Cannes & Antibes Shipyard, Cannes.

Cazes Shipyard, Sables d'Olonne.

Society of Industrial and Naval Construction, Toulon.

Maritimes Gironde Shipyard, Bordeaux.

This gives a total of 153 auxiliary fishing-vessels aggregating 5,714 b.h.p. for which orders already have been placed. Copies of "Motorship" have been sent to the ten shipyards in question, but we would recommend that American oil-engine builders also send catalogues, quotations, and quickest time of delivery and endeavor to secure some of the engine orders for the above vessels and subsequent business.

American Auxiliary Sailing-Ship Makes Record Voyage

Skandia Oil-Engined Vessel Voyages from Aberdeen, Wash., to Queensborough, England, in 67 Days

DURING November three American-built oil-engined auxiliary sailing-ships arrived in the British Isles after very fast voyages from the Pacific Coast of the U. S. A., one of them—the "Mount Hood" making a speed at times ranging from 10 knots to 12 knots, the latter being attained in squalls. She made the trip from Aberdeen, Wash., to Queensborough, England, in 67 days, setting a record for this class of vessel. From Panama to London only took 36 days.

The other vessels were the "Mount Shasta" and the "Mount Hamilton", which are sister-ships specially built for carrying lumber, of which their capacity is one-and-one-half million cubic feet, or approximately 2,500 tons to 3,000 tons.

All three ships, as well as the sister sailing-ship (no motor) "Mount Vernon", left the Pacific Coast port the same time, so the trip was in the nature of a race. The "Mount Hamilton" took 47 days to Kingston and the "Mount Shasta" was 51 days making London, while the sailing-ship "Mount Vernon" had not been reported up to many days after the arrival of the auxiliaries, illustrating the advantages of motor power.

Captain A. Mithassel of the "Mount Hood" informed a representative of "Syren & Shipping" of London that the auxiliary oil-engines were running the entire voyage, and worked throughout without a hitch.

These vessels are owned by the Cornelius Bull Steamship Co. of Christiania, Norway, and have the following dimensions:

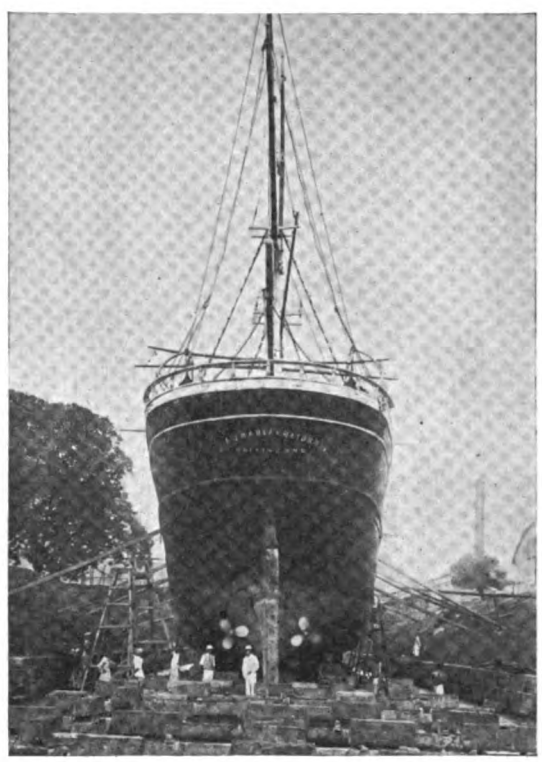
Length B. P.	250′
Breadth	44′
Depth	21′
Power	480 shaft H.P.

Each vessel is propelled by twin Skandia surface-ignition two-cycle type oil-engines of 240 shaft h.p. each. The hulls are said to be as tight as on iron ships after their voyage, and so stiff that they could sail without ballast. The "Mt. Hood" and "Mt. Shasta" were built by the Matthews Shipbuilding Co., Hoquiam, Wash., and the "Mt. Hamilton" was built by the McAteer Shipbuilding Co. of Seattle, Wash.

As yet we have not had any news regarding the sister sailing-ship "Mount Vernon", which had not arrived or been signaled for many days after the auxiliaries had docked, but we presume she is safe in fact by now. In any event this voyage denotes the great advantages of auxiliary oil-engine power.

INDIAN AUXILIARY WITH AMERICAN OIL ENGINES

We are enabled to publish an interesting illustration of the auxiliary barque "Ajrabia Khatoon", through the courtesy of Pyne-Hughman & Co., Ltd., 5, Council House Street, Calcutta, India, who installed a pair of 100 shaft H.P. Fairbanks-Morse heavy-oil engines. She is a wooden vessel 130 feet long by 30 feet breadth of beam and 20 feet depth. Her fuel-tanks have a capacity of 3,000 gallons. There is an independent electric-lighting set, and two motor winches also built by Fairbanks, Morse & Co., of Chicago, Ill.



An Indian auxiliary fitted with Fairbanks-Morse oil-engines by Pyne-Hughman, of Calcutta

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Some Notes on the Design and Construction of Diesel Engines

Conclusions Derived from a Study of Assembled Data

BY "DESIGNER"

[EDITORIAL NOTE.—An article on similar lines by the same author recently published in England, but the author has revised the same, and brought it up-to-date.]

OWING to the comparatively recent development of the manufacture of heavy oil-engines of the Diesel type, both in the United States and Great Britain, and to the fact that all the pioneer work and initial research were carried out on the continent of Europe, it is not surprising that little technical information has been published in English concerning the general principles of Diesel engine design. We have had to rely chiefly upon our foreign competitors who are not inclined to give us any information if they can avoid it. As a result, while a few firms have brought out their own designs, the majority have secured constructional licenses.

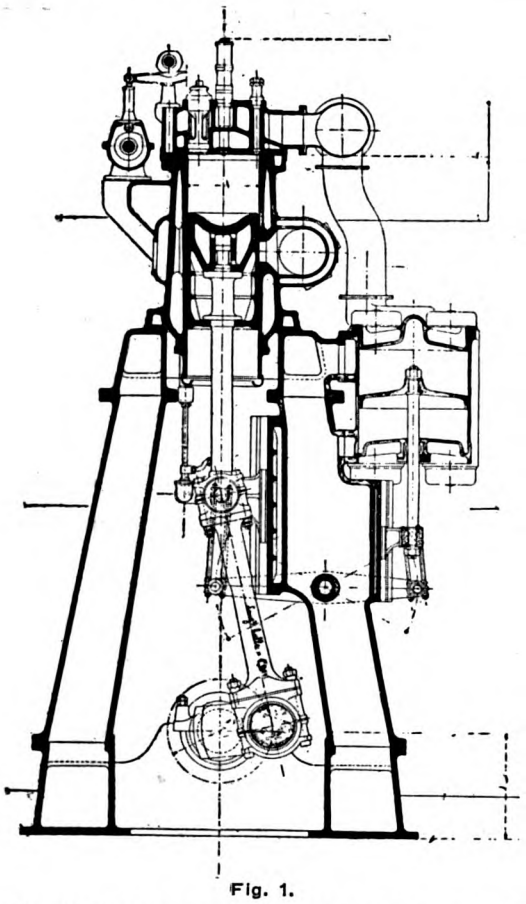

Fig. 1.

It will be not without interest to review the general characteristics of the most prominent Diesel engines and examine as far as possible the different stresses, the loads allowed and the details of construction.

General Conditions

Unlike the conventional triple expansion steam engine having open cranks and castiron columns with which marine engineers are so familiar no special type of construction has as yet been standardized for Diesel engines. For heavy oil-engines it is generally conceded that engines built with enclosed crank cases and employing forced lubrication are by far the most successful in practice, and hence it is very hard to understand why some builders still adopt the old style of open base with its inefficient lubrication by gravity feed.

Due to the heavy loads on the bearings during combustion, forced lubrication is essential to ensure the pressure of a film of oil between the journals and the shells at all times. Many of the earliest Diesel engines which were built along steam-engine lines suffered severely from bearing troubles. Few of the enclosed engines have had this trouble.

Neither does there appear to be any agreement on the style of framing most suitable and efficient for large engines. Smaller engines usually have the box type of crank-case with the cylinders bolted on, as in ordinary gas engine practice, but in the larger engines of the crosshead type each design possesses its distinctive features. The Italian and French designs seem to favor the cast iron column, as shown in Fig. 1, whereas, the Werkspoor Company of Amsterdam, rely upon steel columns as shown in Fig. 2. The B. & W. Co., of Copenhagen, combines these two principles, the cylinders being supported on a totally enclosed crank case, while steel tie bolts extending from the cylinder to the bed plate relieves the crank case framing from any tensile stresses. The Vickers engine has a built up steel framing to support the cylinders. Of the various types the writer considers the basic principles of the Werkspoor and B. & W. systems the most satisfactory, as the steel bolts provide a safe and more direct means for absorbing the tensile stresses than the somewhat uncertain sectional area of the cast iron columns, and consequently, a considerable saving in weight can be made.

While the valve in the head system is almost universal on account of the small combustion space allowable, which in turn is caused by the high compression pressures needed, no two builders agree as to the details of the mechanism for operating the valves.

There is no agreement in opinion among designers as to whether there is any advantage in placing the camshaft at the top of the cylinders as in the Werkspoor, Carels, F.I.A.T., Tosi and other designs (the valves being operated through rocking levers), or whether it is better to place it at the bottom of the cylinders as in the Burmeister & Wain design and operate the valves through push rods. The latter method allows the camshaft to be driven direct by plain spur gears, while the former method necessitates either a vertical shaft and skew gears, the wear on which is very severe, or connecting rods, as in the Werkspoor engine.

Piston Speeds

Two of the most important points to consider in designing an engine are the safe limit of the piston speed, and the most suitable stroke-bore ratio. In Table 1 are given the general dimensions and speeds of a representative number of four-cycle engines of various makes. These are divided into three groups, namely, high speed, medium speed, and low speed. Table II gives the corresponding data for two-cycle engines. We find very different values adopted by different makers. For instance, referring to Table I, we see that for high speed engines (i.e., high r.p.m.) the piston speed varies from 1180 ft. per minute to 550 feet per minute; for medium speed engines it varies from 1040 ft. per min. to 560 ft. per min., while for low speed engines it varies from 820 ft. per min. to 630 ft. per min., the average piston speed thus works out at 850 ft. per min. for high speed engines, for medium speed engines 732 ft. per min. and for low speed engines 733 ft. per min. The corresponding figures for two-cycle engines, taken from Table II are 885, 643 and 752 ft. per min. for high, medium and low speed engines respectively. For high speed engines of the four-cycle type the stroke-bore ratio is found to be low, in the majority of cases around unity, while for medium speed engines the average is 1.4 to 1.0 and for low speed engines it is 1.5 to 1.0. It is interesting to note that the two most prominent designs differ considerably, the Burmeister & Wain Co. adopting a stroke-bore ratio of 1.3 and 1.4 to 1.0, while the Werkspoor Co. use a stroke bore ratio of 1.78 to 1.0 although the piston speeds in the two designs are about the same.

The question of stroke-bore ratio and piston speeds could be discussed at great length, but such a discussion is not within the scope of this article, and we will confine ourselves merely to pointing out the comparative advantages of short and long stroke engines. A short stroke engine has the effect of shortening the period of expansion and so decreases the heat transmitted to the cooling water. On the other hand, a long stroke gives a greater volumetric efficiency. [We suggest

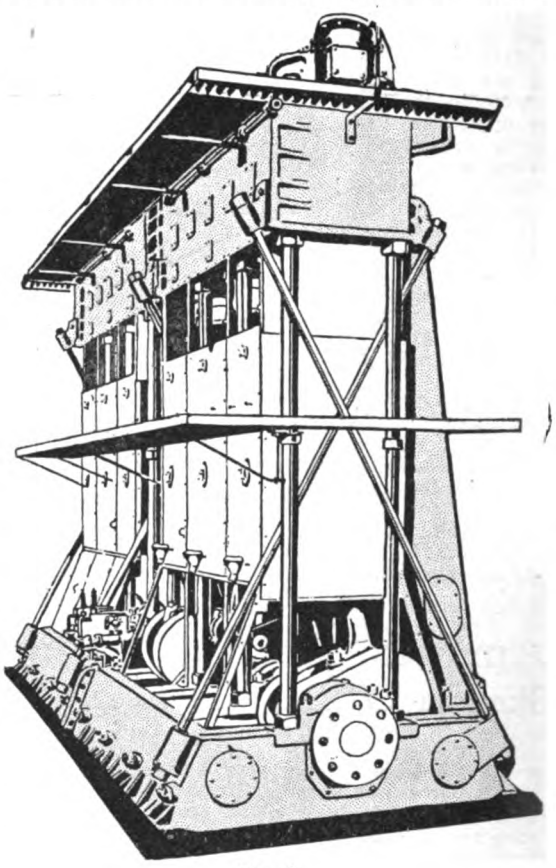

Fig. 2.

TABLE I.—PISTON SPEEDS IN VARIOUS MAKES OF FOUR-STROKE ENGINES.

Make.	Type.	Power	No. of Cylinders	Power Per Cylinder	R.P.M.	Bore	Stroke	Stroke Bore Ratio	Piston Speed	Vol. of Suction Stroke pr. h. p. min.
						Inches	Inches		Ft. Per Min.	Cu. In.
High-Speed Type.										
Nobel	Marine	600	4	150	310	17¾	20	1.13	1040	5115
A.B.D.	Marine	350	6	48	500	11 1/16	11 11/16	1	985	5000
A.B.D.	Marine	450	6	75	400	13¾	13¾	1	915	5440
A.B.D.	Marine	850	6	142	450	15¾	15¾	1	1180	4867
M.A.N.	Marine	100	6	17	600	6½	9 7/8	1.5	1000	5895
M.A.N.	Marine	850	6	142	450	15¾	15¾	1	1180	4867
Krupp	Marine	300	4	75	400	13	13	1	865	4600
Korting	Marine	100	6	17	500	7½	9 1/16	1.26	792	6262
Fulton	Marine	100	6	17	400	8	9	1.12	600	5520
Daimler	Marine	100	4	25	530	7 7/8	9 1/16	1.15	795	4675
Sulzer	Marine	300	4	75	300	15	16½	1.1	825	5831
Burmeister and Wain	Auxiliary lighting	60	6	10	400	7 1/16	8¼	1.17	550	6460
Burmeister and Wain	Auxiliary lighting	180	6	30	400	10¼	9 7/8	1	666	5433
Nlseco	Marine	60	4	15	450	7	9½	1.36	712	5475
Vickers	Marine	1200	12	100	380	14½	15	1	918	4720
Winton	Marine	500	6	83	300	12 5/8	18	1.42	631	4080
Atlas	Marine	110	4	27½	320	9	12	1.33	761	4430
Craig	Marine	175	6	29	400	9½	11	1.16	733	5200
Medium-Speed Type.										
Burmeister and Wain	Auxiliary lighting	200	4	50	225	12¾	17 1/16	1.35	650	4950
Burmeister and Wain	Auxiliary lighting	320	4	80	200	16 1/8	20 7/8	1.27	682	5425
Burmeister and Wain	Marine	540	6	90	250	16 1/16	19 11/16	1.2	814	5652
Craig	Marine	500	6	83	250	14¼	23½	1.65	980	5650
Dow-Willans	Marine	320	6	53	250	12	18	1.5	750	4750
Nlseco	Marine	240	8	30	360	9	12½	1.4	750	4775
Nlseco	Marine	240	4	60	240	13	18	1.39	730	4775
Low-Speed Type.										
Burmeister and Wain	Marine	1650	6	225	100	29½	45 1/16	1.49	724	4925
Burmeister and Wain	Marine	1800	6	300	110	30 1/16	39 3/8	1.31	730	5070
Burmeister and Wain	Marine	1000	8	125	140	20 1/8	28¾	1.38	670	5500
Werkspoor	Marine	2140	6	340	100	26 3/8	47¼	——	787	——
Werkspoor	Marine	1100	6	183	125	22	39 3/8	1.78	820	5125
Werkspoor	Marine	850	6	142	125	20½	35 1/16	1.73	740	5160
Werkspoor	Marine	210	3	70	200	15 5/8	19¾	1.25	660	5485
Vickers	Marine	1250	8	156	140	20¾	33	1.6	770	4970
Sulzer	Stationary	50	1	50	190	13 3/8	20	1.5	630	5340
Tosi	Stationary	450	4	112	180	17¾	26 3/16	1.48	790	5037
Hick-Hargreaves	Stationary	450	3	150	150	22 1/16	31 1/8	1.38	775	6146
M.A.N.	Stationary	70	1	70	160	15¾	23.6	1.5	630	5286

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that our readers consider the question carefully. There are many other features which may be discussed pro and con with respect to each type.—Editor.] For a given piston displacement, the longer the stroke the smaller the diameter, and hence the smaller will be the piston loads and stresses on the crankshaft bearings.

For two-cycle engines the stroke is necessarily longer on account of the ports at the bottom of the cylinder which diminish the effective length of the stroke for expansion purposes. Hence, for low speed two-cycle engines the stroke-bore ratio reaches 2 to 1 and averages about 1.8 to 1.0.

Cylinder Volume

In order to determine the cylinder volume necessary to develop a given power the most reliable method is to estimate the qauntity of fuel required and then calculate the volume of air necessary for its combustion.

The heat equivalent of one horse power per minute is 42.4 B.T.U. Assuming a thermal efficiency of 35 per cent, which we know from experience is attained in Diesel engines, 121 B.T.U.'s must be developed in the cylinder per min. per brake horsepower, or 7,260 B.T.U.'s per hour. Since the average heating value of crude oil or residual oil such as is commonly used in these engines can be taken at 18,000 B.T.U. per lb., we see that the fuel consumption will be 0.4 lb. per horsepower hour, a result which we know agrees with practice within close limits. Now since residual oil is a hydrocarbon (approximately 85 per cent. carbon and 15 per cent hydrogen) the quantity of air necessary theoretically for its combustion can readily be calculated, and is generaly about 178 cu. ft. per lb. Hence theoreticaly the amount of air required to burn 0.4 lb. of fuel per hour, which in turn will develop 1 h.p. per hour is 71.2 or say 72 cu. ft. However, in practice a greater quantity must be supplied on account of leakage, wire-drawing, etc. and also to provide a surplus of excess air to ensure complete combustion. How much excess air must be provided is the question to be settled and it is generally taken to be between two and three times the theoretical amount.

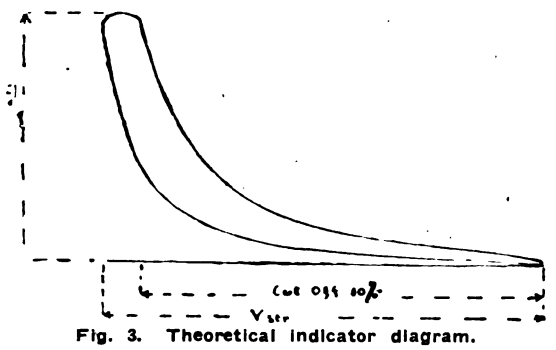

Fig. 3. Theoretical indicator diagram.

Assuming that 2½ times the quantity is decided upon as sufficient, we obtain the necessary cylinder volume required, namely 180 cu. ft. per hour or 5,184 cu. in. per minute. This quantity must equal the total volume of the suction strokes made by the piston per minute for each horsepower developed in the cylinder. To compare this result with practice, this suction volume per horsepower per min. allowed by various designers has been calculated and the results are given in the last columns in Tables I and II. It will be seen that for high speed engines the average volume allowed is 5,120 cu. in. per horsepower per min., while for low speed engines 5,277 cu. in. per horsepower per min. is provided, which agrees very closely with the amount derived from our reasoning, although in some cases the variation is appreciable. For two-stroke engines the average value appears to be higher. This may be explained by remembering that the total piston stroke is greater than the effective stroke, on account of the ports in the bottom of the cylinder.

TABLE II.—PISTON SPEEDS IN VARIOUS MAKES OF FOUR-STROKE ENGINES.

Make.	Type.	Power	No. of Cylinders.	Power Per Cylinder	R.P.M.	Bore	Stroke	Stroke Bore Ratio	Piston Speed Ft.	Vol. of Suction Stroke pr. i.p. min.
						Inches	Inches		Per Min.	Cu. In.
High-Speed Engines.										
Sulzer	Marine	600	6	100	400	12 7/8	11 13/16	1	783	5496
Nobel	Marine	600	4	150	210	16 1/16	19 11/16	1.2	690	5642
—	—	400	4	100	250	12 7/8	18 1/16	1.5	750	5300
M.A.N.	Marine	900	8	112	450	11 13/16	13 3/16	1.13	1005	5875
Korting	Marine	850	6	142	425	13 1/16	13 1/16	1	975	6240
Krupp	Marine	350	6	58	450	9 1/16	11 13/16	1.2	886	6975
Low-Speed Engines.										
Sulzer	Stationary	3750	6	625	136	30	40	1.33	865	6150
Sulzer	Marine	850	4	212	150	18 1/16	26 3/4	1.45	720	5080
Carels	Marine	1800	6	300	100	23 5/8	43 3/8	1.83	722	6338
Carels	Marine	1500	6	250	125	19 11/16	35 1/2	1.8	740	5404
Krupp	Marine	1150	6	175	130	17 1/4	31 1/2	1.83	749	5350
Krupp	Marine	2000	6	333	90	24 5/8	47 1/4	1.92	710	6080
A.B.D.	Marine	800	4	200	165	17 3/4	21 1/4	1.2	588	4345
Swan-Hunter	Marine	600	4	150	135	16 1/16	33 1/2	2	760	6160
Savoia	Marine	440	4	110	200	13 3/4	19 3/4	1.44	660	5332
F.I.A.T.	Marine	2300	6	384	130	24.8	35.4	1.43	767	5752
M.A.N.	Marine	1300	6	217	120	23.6	36.2	1.53	725	8775
Polar	Marine	800	6	133	165	17 11/16	21 1/4	1.2	585	6470

Compression Ratio
Piston Effort

Before we can discuss the stresses obtaining in the various parts of an engine, it is necessary to analyze the pressures acting in the cylinder and on the piston. To find the resultant forces transmitted from the piston to the crank shaft, it is necessary to construct a theoretical indicator diagram for the type of engine under consideration and from it to determine the crank effort.

A theoretical indicator diagram is given in Fig. 3 in which the expansion and compression curves were drawn by the Brauer method. The value of the exponent "n" in the equation $P V^n = C$ is usually taken as 1.3 for the compression stroke and 1.35 to 1.4 for the expansion stroke. The fuel cut off should occur at about 10 per cent of the stroke.

The mean effective pressure is assumed as 100 lbs. per sq. in. on the piston, although in practice it varies from 90 to 110 lbs. per sq. in. at full load in different makes of engines. The piston effort curve can be then drawn out and the inertia curves added when the weight of the reciprocating parts is known. The resultant piston effort curve is given in Fig. 4, from which the tangential effort diagram Fig. 5 is constructed. Fig. 6 shows the combined curve for a four cylinder engine. It will be seen that the maximum turning effort occurs about 30 degrees past the upper dead centre of each crank.

Cylinders

The pressure in the cylinder may be considerably higher than the average working pressure when starting up or if operating with a broken or leaky injection valve, and it is usual to allow a safe margin when designing an engine. A maximum pressure of at least 600 lbs. per square inch should be assumed. Cylinder relief valves should be set to lift at this pressure in order to prevent any great excess pressure which would impose undue stresses on the engine members.

There are three distinctive methods of cylinder construction in use. Firstly, a separate liner is pressed into an outer jacket, the liner being free to expand at the bottom, while a water-tight joint is secured by means of rubber rings fitting into V-shaped grooves in the outer surface of the liner. The top joint between the liner and the jacket is made by caulking the joint with copper wire, as shown in Fig. 7, or in some cases the cylinder head is spigoted and a ground joint is formed by the spigot, as shown in Fig. 6. The cylinder head is separate, and made gas tight by means of a ground spigot joint, this being the only method suitable for withstanding the high pressure.

The second method is to cast the cylinder-head and liner in one piece, which is then fitted into the jacket as in the first case. This construction gives better cooling around the valve pockets and combustion chamber, but necessitates the scrapping of both cylinder head and liner if either of them develops a crack. The system is employed on the Werkspoor engines, and on some two-cycle designs. [The author is not quite correct here as while the cylinder and its cover of the Werkspoor engine are cast in one, a separate liner is pressed into the cylinder.—Editor.]

A third method employed on some small engines is to cast the liner, jacket and cylinder-head all in one, as in the Nelseco engines. This construction is cheaper than those previously described, but is not to be recommended for any except small engines.

Cylinder liners should be of close-grained cast-iron, the maximum fibre stress allowed being 3,000 to 3,500 lb. sq. in. Using Bach's formula for the thickness of cylinders, and assuming the maximum pressure to be 600 lb. sq. in., we find that the thickness of the liner should be 0.105 D, an allowance of ⅛ in. to ¼ in. being added to allow for reboring.

Grinding the cylinder bore is perhaps the most satisfactory finish, even in the largest sizes, as it is imperative that the bore be dead true and smooth. Liners should be rough bored and allowed to stand for some days before grinding to insure that the casting is free from foundry strains. [The opinion among the majority of builders is that only the pistons and not the cylinder-liners should be ground.—Editor.] Probably one of the most important details in the manufacture of Diesel engines is the securing of a correct mixture for the liners, owing to the heat stresses to which they are subjected. Only foundries experienced in such work should be trusted to make them.

Considerable stresses are experienced in the frames during the period of combustion, consequently cast-iron columns are seldom used by themselves. An excellent method of construction is shown in Fig. 2 as used in the Werkspoor engines, where steel tie bolts are carried up to the top of the cylinder cover from the bedplate. All the stresses are taken by the bolts, so that the jackets and crankcase are in compression only due to the tightening up of the bolts. Consequently they can be very lightly constructed, and the weight of the engine considerably reduced. The crosshead guides of the Werkspoor engine are carried on cast-iron columns which absorb the thrust.

Another method sometimes employed is to bring the steel bolts to the bottom of the cylinders, in which case the latter must be heavily constructed to take the tensile stress, although the lower frame may be lighter. Cast-iron "A" columns are hardly ever met with in marine practice. Bedplates call for no special comment, except that a sump must be provided for the lubricating oil to collect in. Totally enclosed crankcases are usually adopted, as they permit a much cleaner engine-room. Engineers are learning the value of forced lubrication and are beginning to realize that an engine will run for weeks without it being necessary for anyone to see the moving parts go round.

(*To be continued in our next issue*)

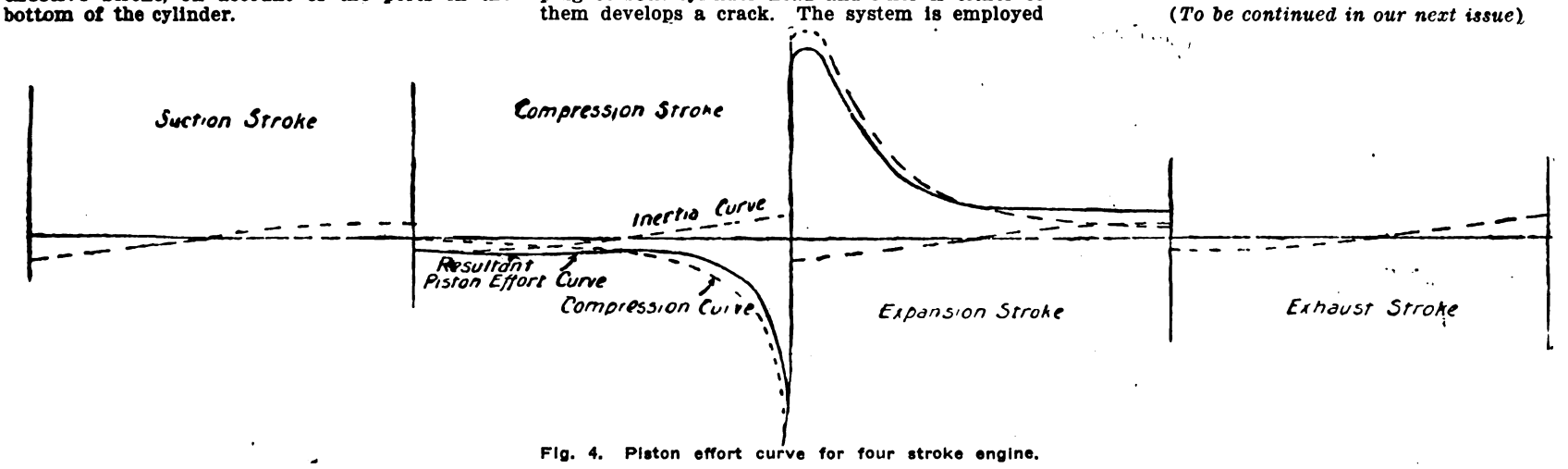

Fig. 4. Piston effort curve for four stroke engine.

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Domestic and Foreign Coastwise New Motorship Construction Notes

Those who take the trouble to regularly read the small news paragraphs regularly published in our columns will have noticed that in Scandinavia dozens of Diesel-engined and surface-ignition oil-engined vessels from 150 to 2,500 tons are placed in service each month. They have proven to be most economical craft, although fuel-oil is both scarce and expensive in Scandinavian countries. Among new coastwise vessels may be mentioned a 350-ton full-powered craft built by the Ved Vasterviks Nya Varvsaktiebolag, of Vasterviks, for the Vesterviks Rederiaktiebolag of the same town. A 120 b.h.p. Bolinder oil-engine is installed. A motor-vessel of 500 tons and one of 700 tons also are under construction at this yard. In the latter craft a 240 b.h.p. Bolinder motor will be installed.

* * *

A motor-schooner of 600 tons d.w.c. has been built by the Svendborg Skibsverft and Maskinbyggeri of Svendborg, Denmark, in which a 160 b.h.p. Holeby four-cycle type Diesel-engine is instaled. A 60 b.h.p. Diesel oil-engine has been installed in the 120 tons net register schooner "Orkney" owned by Rechnitzer, Thomsen & Co., of Aalborg, Denmark.

* * *

Mr. S. B. Pettersson, of Uddevalla, Sweden, has taken delivery of the wooden auxiliary-schooner "Samros" of 317 tons gross. In this vessel twin Bergsunds heavy-oil engines are installed. The hull was built during 1919, by the Aktiebolaget Stromstads Mek. Vaerkstads of Stromstad.

* * *

Among Swedish shipowners who have adopted the motorship may be mentioned the Rederiaktieb Sjofageln (R. Hain, Manager) of Malmo, Sweden. Their new vessel is the 300 tons gross composite schooner "Sjofageln", built by the A. B. Malmo Yachtvarv of Limhamn, Sweden, and a Bolinder oil-engine is installed as auxiliary power.

* * *

American oil-engine builders should communicate with the Cia Maritima Santa Ana, of San Sebastian, Spain. This company is adopting auxiliary wooden motor-vessels. Their latest ship is the "Santa Ana", 187 tons gross, built for them at Pasajes, and powered with a Bergius kerosene engine built in Scotland.

* * *

To the order of the Anglo-Norwegian Shipping Agency of Christiania, Norway, and of 17 Battery Place, New York City, the Elliott Bay Shipbuilding Co. of Seattle, Wash., have completed the 2,200 tons gross wooden auxiliary-schooner "Kirketind". In this vessel twin eight-cylinder Winton Diesel engines are installed.

* * *

The wooden three-masted schooner "Aasta" has been placed in service by her owner Mr. K. S. Nordgreen, of Bergen, Norway. This vessel is of 320 tons gross, and was built by Otte Nielsm, of Stord, and is propelled by a pair of heavy-oil engines built by the A. S. Norsk, Motorfabrik, of Bergen.

The wooden screw motorship "Andora", of 442 tons gross, is now in service and is operated by Quaglia & Galdini of Genoa, Italy. She is fitted with a six cylinder 9-4/4 bore by 10-3/5 inch stroke Ansaldo San Giorgio Diesel engine, and the hull was built by the Canteri Navale di Andora, of Andora, Italy.

* * *

The new three-masted steel schooner "Emily", of 423 tons gross, is now owned by the Cocoto Navigation Company. She was built in 1919, and the oil-engine was constructed by the A. B. Motorenfabrik d'Industrie Alphen, of Ryn, Holland.

* * *

Two four-cylinder 11-4/5 inch bore by 16-1/2 inch stroke, four-cycle type Holeby Diesel engines have been installed in the four-masted steel schooner "Mogens Koch", owned by Mr. M. Koch of Ronne, Denmark. The hull was built by the Svendborg Skbsv. & Mskb. of Svendborg, Denmark.

* * *

For the Morocco service the 120 tons net auxiliary-schooner "Orkney", has just been completed by the Th. Anderson Vaerft of Odense, Denmark, for the Rederick "Orkney" of Aalborg. She is propelled by a single-cylinder oil-engine of 150 b.h.p. and her trials have been successfully run.

* * *

Trials have been run of the four-masted auxiliary-schooner "Gerda", built for the Balliske Rederi, of Copenhagen, Denmark, by the Fredriksund Skibsvaerft, of Fredriksund, for the Island-Spain trade. A four-cylinder Tuxham oil-engine is installed and a speed of six knots was obtained.

* * *

At the Winsnes shipyard in Fane, Norway, a single-screw 300 tons fish and cargo carrier named "President Wilson" recently ran trials. Her 300 h.p. **steam** engines are American built. Very few vessels building in Norway will have steam machinery.

* * *

Among the numerous wooden and steel motorships varying from 200 tons to 10,000 tons d.w.c., now under construction in Italy, are six 450 tons d.w.c. wooden vessels now building at Messrs. Ansaldo's Multedo and Voltri shipyards. These ships have the following dimensions:

Length, overall	43.10 meters
Length, between B.P.	40. "
Breadth	8. "
Beam of outside frame-work	7.84 "
Total Depth	4.4 "
Draught	3.60 "
Corresponding displacement	800 tons
Carrying-capacity	450 "
Registered tonnage	350 "
Power	420 shaft h.p.
Speed of vessel, loaded	9 knots

In each ship a four-cylinder, two-cycle type, Ansaldo-Sulzer Diesel engine of 420 shaft h.p. is being installed. This is as much power as installed in some American wooden auxiliary vessels of **seven times** the tonnage of these vessels.

* * *

Both in China and Japan the heavy-oil engine is making a considerable headway in merchant shipping circles. The Chung Kwok Po Lee Steamship Co., Ltd., at Canton, have taken delivery of the wooden twin-screw auxiliary schooner "Yuet Shang" of 704 tons gross, built during 1919, by the Kwong Tuck Cheong, of Hong Kong. In this vessel an eight-cylinder 12 inch by 16 inch heavy-oil engine, built by the Kong Tuck Cheong, of Hong Kong, is installed.

* * *

"Tanjong Rhu" and "Tanjong Kling" are the names of the two 2,500 ton dead weight motorships that have recently been built at Singapore by the Anglo-Chinese Shipping Company. In both vessels two 350 shaft h.p. Skandia surface-ignition oil-engines are installed.

* * *

An oil-engine built by the Steywal Motorfabrik of Voergchie, Holland, has been installed in the 254-tons gross steel vessel "de Lauwers", owned by the Nederlandsche Stm. Maats Bastevaer (C. Goudrien & Co., Managers) of Amsterdam.

* * *

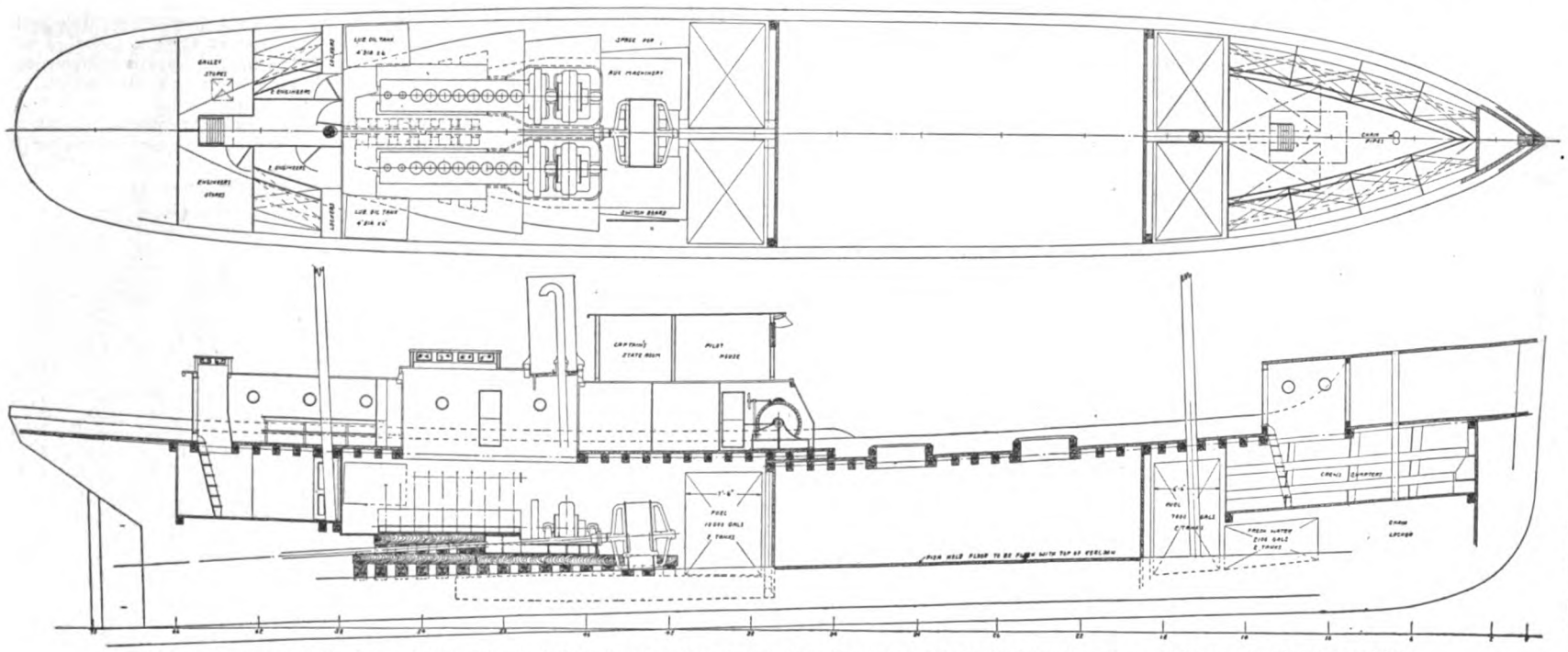
Trials were run in October of a 465 tons d.w. motor-schooner named "Nykbing", which was constructed at the Mors Shipyard, Ltd., Glynogre, Denmark. She has a four-cylinder oil engine of 140 B.H.P., manufactured by the Densil Motor works, Aalborg, as well as a "Diesel deck-motor for working the winches and a fire-pump. The "Nykbing" started from Glyngore and run to the harbor of Aalborg, covering the distance at a speed of 8 knots. The engine worked to the best satisfaction. The next day she set off for the Faroe Islands, thence to Spain.

* * *

The motorship "Danekonge," 1,420 tons gross, a twin-screw steel auxiliary, has been completed by the Akt. Rodby Havns Jernskibsv, Rodby, Havns, Denmark, and delivered to her owners, the Dampskibsselskabet Oceana (Suenson & Jespersen) of Copenhagen. Two four-cylinder, four-cycle type Holeby Diesel-engines are installed. The vessel is 247 ft. long by 40 ft. breadth and 23 ft. 7 ins. depth.

* * *

In the new motorship "Fanefjord" built by the Bolsonaes Skibsbyggeri & Mek. Verksted A/S of Molde, Norway, a four-cylinder, two-cycle type, 230-260 b.h.p. Konkurrent heavy-oil engine has been installed, and the deck and engine-room auxiliary machinery are operated by a 16 H.P. engine of the same make. The engines were constructed by the builders of the hull. The owners of the vessel are the A/S Romsdale of Molde. The vessel in question is of 664 tons net register, and is about 125 feet long between perpendiculars.



General arrangement plans of the Diesel-electric trawler "Mariner", described and illustrated in the Dec., 1919, issue of "Motorship".

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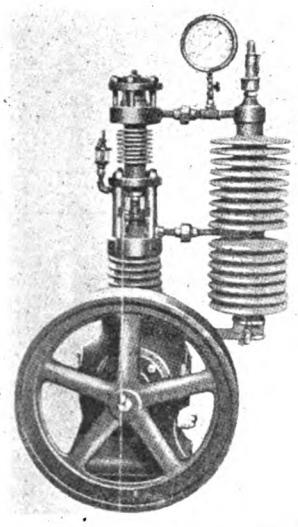
A SMALL INDEPENDENT AUXILIARY AIR COMPRESSOR

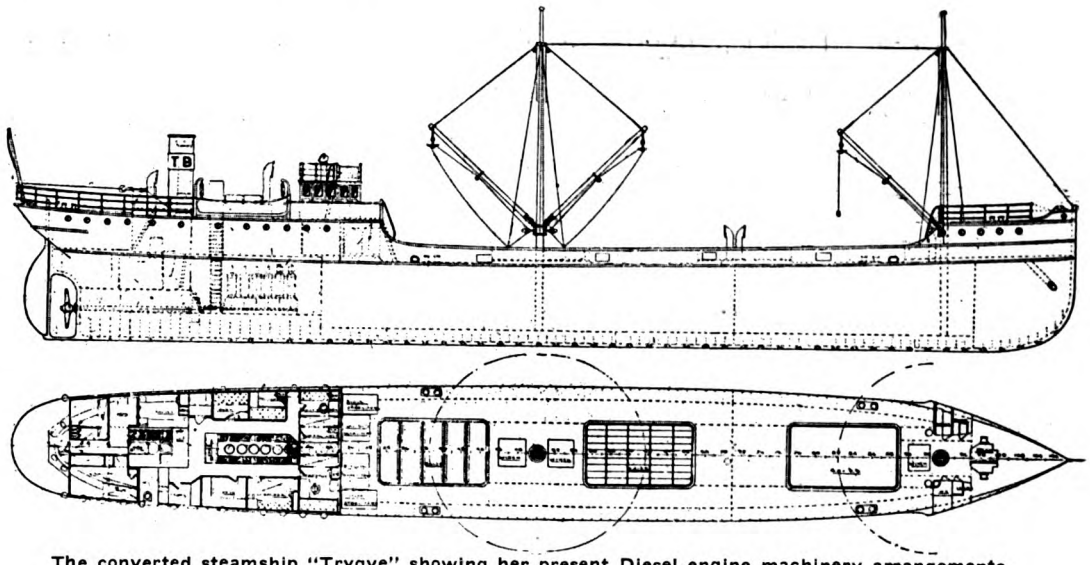
The five additional motorships ordered for the Australian Government will have as auxiliary equipment for compressing air, small motor-driven units supplied by the Rix Compressed Air & Drill Co., San Francisco, Cal.

These compressors are made in several sizes, the one shown being 3 ins. x 1 in. x 3 ins. x 2 ins. stroke for pressures from 250 to 1,000 lbs. per sq. in. The high pressure piston may also be supplied ⅞ in. dia. for pressures up to 1,500 lbs. The piston displacement is 7 cu. ft. per minute at 600 r.p.m. and it absorbs 3 to 5 h.p. depending on the speed and pressure. Splash lubrication is used in the crankcase and a sight-feed lubricator is used for the high-pressure piston. A pressure gauge is fitted and a pop-valve connected to the inter-cooler which, like the compresser cylinders is air-



Rix two-stage air-cooled compressor for pressures 250-1500 lbs. per sq. in.

cooled. The total weight is 200 lbs. without the motor. Larger units are made suitable for delivering starting and maneuvering air at 350 per sq. in. The particulars of this machine are: Piston displacement 75 cu. ft. per minute at 350 r.p.m. cylinder bore and stroke 9 ins. x 3½ ins. x 6 ins., weight without motor 1,000 lbs., gear driven by a G.E. 25 h.p. D. C. motor, taking current at 115 volts. For emergency a delivery pressure of 1,000 lbs. can be obtained for short periods by throttling the inlet air about 50 per cent. For continuous running a small booster can be provided to take air at 350 per sq. in. from the maneuvering tanks and deliver it at 1,000 pressure. This machine has a 1⅛ in. bore and 3½ in. stroke and compresses 8 cu. ft. of free air per min. when running at 550 r.p.m. Its weight alone is 375 lbs.



The converted steamship "Trygve" showing her present Diesel-engine machinery arrangements, referred to in a recent issue

PROOF OF THE PUDDING

It will be remembered that the motorship "Cathana," built for the Australian Commonwealth, entered into Pacific service in 1918. She is a wooden vessel built in the Puget Sound country and has proven a success from every angle. Her power plant consists of two McIntosh & Seymour Diesel engines.

Below is an abstract of the engineer's log of a voyage last winter from Honolulu to San Francisco in ten days. As seen by the table the average distance made good after noon of the first day wash about 205 miles per day, or a sustained sea speed of 8.54 knots.

IMPORTANT STEP TOWARD CONVERTING EXISTING STEAMERS

Heretofore persons not thoroughly conversant with the development of the marine Diesel engine have considered it as an aspirant for merely a secondary place in the field of marine propulsion. Its suitability for new installations has been argued pro and con without cessation, and its speed has always been used as an argument against its use; but, now we have passed the point where arrangements are possible to actually replace present low-speed reciprocating steam machinery with Diesel oil-engines, and many successful installations are in service. Incidentally a well-known Danish firm has evolved a slow-speed, long-stroke motor to be built in sizes from 750 to 2,400 i.h.p. in six cylinders to run at 70 to 84 r.p.m. and which engine will also be built by a Swedish concern. This will permit existing shafting, spring bearings, stern-tubes and propellers to be used when steamships are converted to Diesel power. Although they will be not much lighter in weight than the steam plants, by reason of the reduced bunker space, they will save an appreciable amount of cargo room, and will have greatly increased cruising radius, besides lowering the operating expenses.

ENGINEER'S LOG
MOTORSHIP "CETHANA"
FROM HONOLULU TO SAN FRANCISCO

Date	Length of Day Hrs.	Min.	Rev. Per Min.	Miles By Eng.	Miles By Ship	Miles Per Hour	Slip Per Cent	Total Fuel 2 Engs	Donkey Boiler	Total Cons.	Lub. Oil Gal.	Inj. Air	Exh-aust	Gal. Per Hr. Per Eng.	B.H.P. Basis .41 lb. Fuel B.H.P.H.	Load Fac. BHPx185 500xR.P.M.	REMARKS
11/9	Left 5:10P		164 167 170	....	....	....	....	60	60	40860	1.5	850	Clear	....	....	....	Turn taken on engines 3:30 P.M. Everything satisfactory. Strong head gale—Heavy sea—Engines racing all watches. Changed filter cloths—Made joint on fuel pump.
11/10	18	30	174 166	192.4	124	6.5	35.6	1010	560	1570	6-.5	850	Clear	27.2	497	1.08 1.055 1.12	Strong wind to moderate gale—Ship rolling heavily—Engines racing. Ship rolling and pitching heavily—Heavy squalls—Rough seas—
11/11	23	50	168 168	242.7	155	6.5	40.	1314	500	1814	7-1	850		27.5	504	1.105 1.09	Engines racing all watches—Maneuvering tanks working over ¼" shores creaking and cracking every time ship rolls. Noticed strain on steering engine—reported to 3rd Officer.
11/12	23	48	170 164	238	136	5.7	42	1298	500	1798	7.5-1	850		27.2	497	1.08 1.13	Fresh gale and high sea—Ship rolling and plunging—Decks flooded—Maneuvering tanks moving with rolling of ship—Returned to Honolulu for repairs to rudder—Turned at 9:30 A.M. Following sea and wind after turn—Rudder badly damaged. 6 P.M. stopped Starb'd eng. to prime No. 1 Cyl. 15 minutes. Cleaned main engine filters.
11/13	24		166 176 180 178	221 50	127 22	6.0 8.0	42.5 20	1323	500	1823	8-1	850		27.4	501	1.12 1.04	
11/14	24	44	180 176	267	200	8.2	25	1355	510	1865	8.5	850		27.4	501	1.03 1.115	Strong following wind and sea—Rolling heavily. Similar weather and conditions.
11/15	23	16	180	264.8	220	9.0	17	1355	510	1865	9.5-1	850		29	530	1.09	
11/16	10	35			105	9.9		655	500	1155	4.5-.5	850		30.8	563		Anchored 11:30 P.M. Turned engines 10 A.M. All O.K.
Work Done at Honolulu			11/18 11/19 11/20														
Cleaned fuel valves and needle valves Port engine. Port daily supply tank cleaned. Tightened holding down bolts, main engines. Spare exh. valve ground in—Cyl. Hd. No 6 Starbd. taken off—Broken studs in exh. flange being drilled out—Piston being lifted Piston pin taken out—Brasses and pin in good condition. Cyl. walls in good condition. New rubber joints in Cyl. Hd. Crank. Pin brasses checked and adjusted. HP Compressor delivery valve Stardb. cleaned and ground in. Filter cleaned. Exh. pipe new joints made. Maneuvering tanks shored up by shoremen.																
11/22	1	15	176 180 176	....	11	9.0	....	60	490	550	1-1	800	Clear	24.	440	.925 .905 1.075	Started 10:43 A.M. Light breeze and smooth sea. Put joint No. 6 Cyl. Exh. connection.
11/23	23	36	180 176	257	212	9.0	17.6	1324	500	1824	11-1	800		28	512	1.05 1.075	Mod. breeze Heavy west swell—Ship rolling heavily. Turn of packing put in No. 3 and No. 5 fuel pump glands Stbd. Eng.
11/24	23	40	180 176	258.3	216	9.1	16.4	1328	500	1828	9-.5	800		28	512	1.05 1.075	1 Gal. lub. oil into oil system. Strong wind—Starboard bow.
11/25	23	46	180 174	259.4	212	9.	18.3	1328	500	1828	9.5-1.5	800		28	512	1.05 1.065	Turn of packing into No. 1 fuel pump Stbd. Fresh breeze. Frequently heavy squalls. Lub. filter cloths changed.
11/26	23	48	178 170	257	202	8.5	21.4	1305	510	1815	9-1	800		27.4	501	1.04 1.10	2 Gals. fresh oil put in fuel pump eccentric boxes. Moderate gale—Rough sea—Shipping water.
11/27	23	48	174 174	247	186	7.8	24.5	1290	510	1800	10.5-1	800		27.7	506	1.075 1.075	Fresh wind—Moderate sea—Overcast with rain.
11/28	23	48	176 176	249.9	198	8.3	20.9	1322	500	1822	10.5-1	800		27.7	506	1.06 1.08	Moderate wind and sea Overcast and dull. Stbd. eng. stopped 10 minutes to pack No. 1 and 5 fuel pump glands.
11/29	23	48	180 174	251	202	8.5	19.5	1345	520	1865	21-1	800		28.2	515	1.06 1.115	
11/30	23	48	178 174	259	218	9.2	16	1370	520	1890	20.5-1	800		28.7	525	1.09 1.12	Light wind and smooth sea.
12/1	23	42	176 176	254	218	9.2	14.5	1368	510	1878	11-1.5	850		28.8	527	1.105 1.10	Light to moderate wind and sea.
12/2	23	42	180	....	209	....	....	1360	520	1880	11-2.5	850		28.6	524	1.075	

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Interesting News and Notes from Everywhere

A NEW MILLION DOLLAR AMERICAN MOTORSHIP BUILDING CORPORATION

Under the laws of Delaware the United States Diesel & Shipbuilding Corporation has been incorporated with a capital of one million dollars.

FIAT 1300 B. H. P. MARINE DIESEL ENGINE FOR DISPOSAL

Among the marine-type Diesel engines offered for sale by the British Admiralty we note a six-cylinder 1300 b.h.p. at 360 R.P.M. two-cycle type Fiat San Giorgio motor.

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America's latest submarine—the S-16—launched at Bridgeport. She is propelled by two 600 B.H.P. Busch-Sulzer Diesel-engines, and has a displacement of 1,200 tons.

LAUNCH OF 10,500 TONS MOTORSHIP FOR STANDARD OIL SUBSIDIARY

(*Continued from page* 35)

The "Diesel" engines of the "Narragansett" each will have six-cylinders 25 ins. bore by 36 ins. stroke, and have an output of almost 250 I.H.P. per cylinder, compared with 187 per I.H.P. with the engines of the tanker "Santa Margherita", also built by Vickers. Other motorships built and engined by Vickers are the tanker "Trefoil" and the monitor "Marshal Soult", also eight 1,800 shaft H.P. sets for twin-screw tankers for the Anglo-Saxon Petroleum Co. This makes a total of 13 Vickers "Diesel"-engined vessels built or building, without counting several hundred submarines of up to 3,600 shaft H.P. per boat. So we should estimate that their investment in "Diesel"-engine research work must have been repaid many times, especially as in Great Britain alone they have twenty constructional licensees.

MOTORSHIP BUILDING ON THE STRAITS OF MAGELLAN

According to Consul Austin C. Brady, Punta Arenas, Chile, the largest vessel yet built in the Straits of Magellan is the motor auxiliary sailing-ship of 900 tons displacement and of wooden construction. She has been built for the La Sociedad Ganadera Gente Grande at Puerto Harris, Isle of Dawson, at their own shipyard. This is a Chilean Company under English management. Two motors of 100 b.h.p. each are installed as auxiliary propelling power.

"DOES HE MEAN US?"

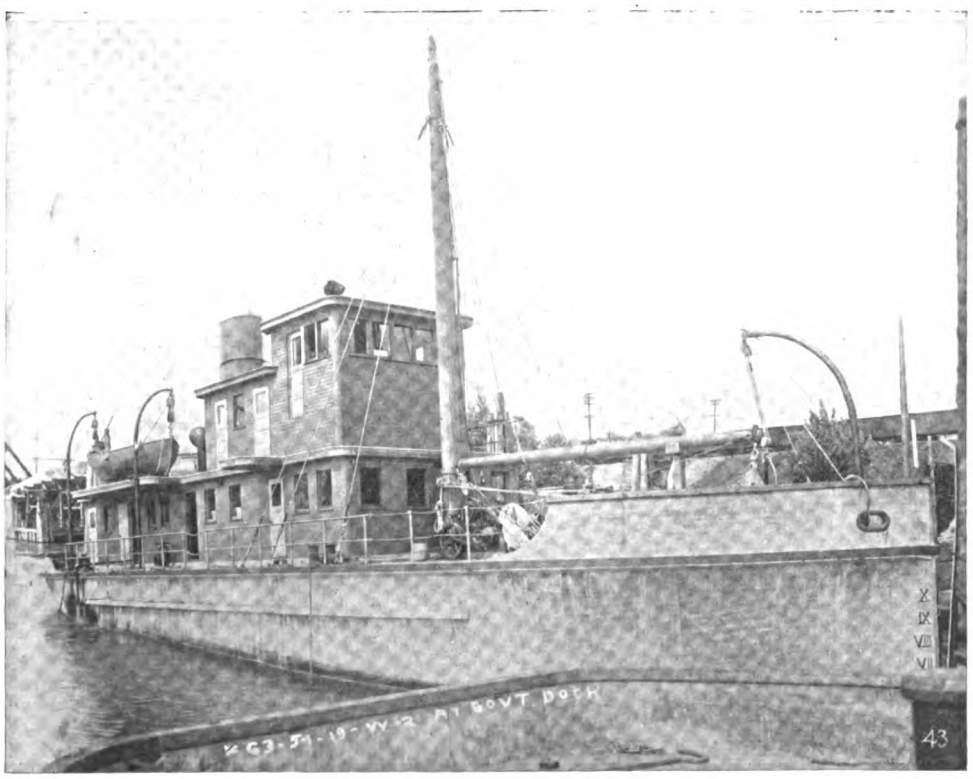
In a paper read before the College of Naval Architects and Engineers of Rome, Signor Napoleone Albini said that **America**, which at the out-set allowed the free choice between reciprocating and turbine engines for standard vessels, found herself impelled by the campaign conducted by the **German Technical Press** to also decide on accepting the Diesel motor. This is the first time "MOTORSHIP" has been told that it was a German publication and we wonder what the Chief will say when he hears it! Readers may remember that Capt. Freeman trained about 30,000 men for the U. S. Navy. So, as a famous comedian would say—"Albini, you surprise us!"

AMERICAN ENGINE CANADIAN AUXILIARY

Among wooden auxiliaries recently built in Canada may be mentioned an 1800 ton d.w.c. vessel constructed at the yard of the St. Martins Shipbuilding Co. of St. Martins, New Brunswick. The name of this vessel is the "Quaco Queen" and she was built to their own order. A 200 Fairbanks-Morse oil-engine is installed. She recently made a voyage to the United Kingdom with 550,000 ft. of lumber.

A NEW DIESEL ENGINE MANUFACTURERS' ASSOCIATION

It is reported that a new association, known as the California Diesel Engine Manufacturing Company, has been incorporated with a capital of $50,000.00 by T. C. Moore of San Francisco.



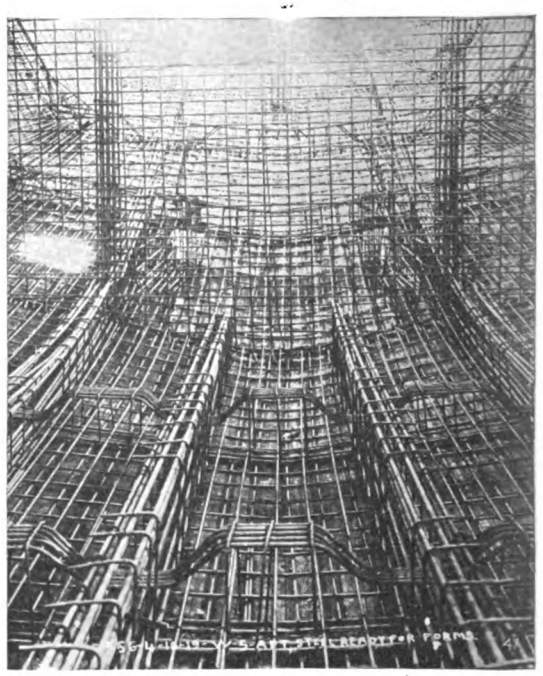
One of the U. S. War Department's 100-ft. concrete motorships. Drawings and complete details were published in "Motorship" for December, 1918, pages 23 to 25. Frisco-Standard distillate engines are installed.

WORLD'S LARGEST MOTOR TANKER

Among the twelve American-owned ships (German operated) that were ordered to the Firth of Forth for allocation between the Allies are the big motorships "Loki," "Wotan" and "Wilhelm A. Riedermann." The latter is one of the largest Diesel-driven vessels in the world, being a tanker of 15,000 tons d.w.c. and of 4,000 i.h.p. Her length is 525 ft. by 66 ft. 3 in. breadth, 41 ft. 3 in. depth and 27 ft. 9 in. draught. Speed 10½ knots.

JAPAN'S NEW SUBMARINES

With reference to the new triple-screw 12,000 shaft h.p. Diesel-engined submarine cruisers, which Japan is to build, we note that $824,000,000 will be spent for an eight-years' programme which will include seventy submarines, four battleships four battle-cruisers, twenty light-cruisers, eight destroyers and thirty other craft. As $150,000,000 to $200,000,000 should be sufficient to cover the cost of all the other craft it looks as if most of the money is to be spent on the submarines, indicating that they will be of very large size, such as the 12,000 b.h.p. craft referred to in our November issue.



Steel-work of U. S. War Department's concrete motor vessels

NEW ASPINALL GOVERNOR

On most large ocean-going motorships an Aspinall governor is fitted to the Diesel propelling-engine. Builders of marine machinery will be interested to learn that developments are now being made by the Aspinall people with the new governor specially designed for internal-combustion engines.

DUTCH 450-TON MOTOR TUG

A motor tug of 450 tons named "Leksveer" has been launched by the Scheepswerf v. h. de Jong of Groningen, Holland. Also a motor tug named "Edith" has been launched at Alkman, Holland.

LAUNCH OF DANISH 13,000 TONS MOTORSHIP

The Diesel motorship "Afrika," 13,000 tons d.w.c. has been launched at Copenhagen to the order of the East Asiatic Company.

DIESEL PAPER TO BE READ

Mr. Hubert Verhey, Chief Engineer of the Diesel Engine Dept. of the U. S. Emergency Fleet Corporation will read a paper entitled—"Modern Practice in Marine Heavy-Oil Motor Installations and Development Possibilities" before the Philadelphia Section of the American Society of Mechanical Engineers on Jan. 22, 1920.

HOW SWEDISH SHIPOWNERS ENCOURAGE MOTORSHIP CONSTRUCTION

In order to push forward the construction of motorships in Sweden, the leading shipowners of that country advance one-half of the total cost of the machinery and hull to the builders at 5%, while the Government loans the shipowners a certain amount per ship. Meanwhile many American shipowners remain in blissful slumber,—and so the world goes on!

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Another American-Built Motorship for Norwegian Owners

M. S. "Semmiltind", Sister Ship to M. S. "Trolltind", Now in Service

Another full-powered motorship, the "Semmiltind," has been completed by the Elliott Bay Shipbuilding Company of Seattle, Wash., and has lately been placed in commission by the owners, the American Motorship Company of Christiania, Norway, and loaded 2,000,000 feet of lumber at Portland, Oregon, for her maiden voyage. On her trial trip this vessel averaged more than 10½ knots for over five hours. The sister ship of the "Semmiltind," the "Trolltind," powered with the same size and make of engines completed the first lap of her maiden voyage to San Francisco from Puget Sound enroute to Denmark with an average of 8¼ knots for the entire trip, her engines turning 190 revolutions per minute. Twin eight cylinder, 500 b.h.p. direct reversible, Winton-Diesel motors of the four-cycle types are the power plants of these two ships.

Most noticeable when making an inspection of these vessels is the arrangement of the engine-room. Ample space has been provided for the main and auxiliary engine equipment. The engine-room is aft, but practically the full midship width is maintained for the arrangement of the machinery. The quarters for the deck officers, the engineering staff and the captain have also been placed aft. The crew's quarters are in the forepeak where a generous space has been provided with conveniences not found on many such vessels larger than the "Semmiltind" or "Trolltind." These ships each have tank capacity for 1,550 barrels of fuel, 850 barrels being in tanks on the lower deck level of the forepeak and 700 barrels in the 'tween decks aft. In addition to the foregoing provision has been made for 200 barrels of water and for 150 barrels of distillate and lubricating oil.

On the starboard side of the engine room is a 6 x 8 Rumsey triplex bilge pump made by the Rumsey Pump Company of Seneca Falls, N. Y. This pump is driven by means of a three cylinder, 40 h.p. Atlas distillate motor which also drives the auxiliary Winton air-compressors. This equipment is in the lower engine-room. A Fairbanks-Morse generating set is located on the port side and consists of a 20 b.h.p. type "Y" oil engine direct-connected to a 115 volt generator supplying power for lighting, electric steering gear and for the electric fans. This generator also supplies electricity to a small 3 h.p. motor which drives a 3½ x 3½ Clayton air-compressor. This compressor supplies air for the ship's whistle and is an auxiliary to the steam pumps. It can be operated until steam pressure is obtained from the donkey boiler. The Fairbanks Morse oil engine also drives a 3 x 4 Rumsey pump used for fire, bilge and for filling the sanitary tanks. An auxiliary 120 volt generator is also provided, being geared to the fly wheel of the port main engine. This generator supplies power for the ship's lights, steering gear and the ship's fans while the vessel is at sea. All the electrical generators installed aboard the ship were built by the Fairbanks Morse Electrical Manufacturing Company of Indianapolis, Ind.

An oil-fired donkey boiler made by the Seattle Boiler Works, Seattle, Wash., supplies steam for the cargo hoists, anchor windlass and for the capstan on the after deck. The fuel oil is pumped to the burners in the donkey boiler by a Wilgus pump, made by the Wilgus Mfg. Co. of Los Angeles. Steam for the American Radiator Company's hotwater heating system installed throughout the vessel is obtained from a small boiler located on the same level with the donkey boiler. A McGowan duplex pump is located at the after end of the starboard engine and is used to pump boiler feed from the main tanks and hot well. Two Worthington steam pumps are installed aft of the starboard engine. One is used for circulating water around the exhaust line and the other as a distribution pump for the main fuel line, distributing oil from one tank to the others in case of an emergency. Instead of a condenser on these vessels exhaust tanks have been installed. This takes the exhaust from the steam equipment, condenses it and then returns it to the boiler by means of the McGowan pump mentioned above.

The lubricating oil for the main engine is passed through a Peterson type Richardson-Phenix oil filter.

The ship's switchboard was made by the Ward Leonard Switchboard Company of Mount Vernon, N. Y. At the base of the panel and attached to it are the starting resistances for the Clayton air-compressor and the small steering gear motor. These resistances were supplied by the Union Electric Mfg. Co. and the Cutler Hammer Electric Company, both of Milwaukee, Wis.

Steering is accomplished by means of an electric steering gear designed and built by the Markey Machinery Company, Seattle, Wash., and is identical to that installed aboard the "Trolltind." Cutler Hammer electrical apparatus has been used throughout in the construction of this steering gear.

A capstan located on the after deck and made by the Drake Engine Company, Grand Haven, Mich., is operated by steam from the donkey boiler.

Fire protection aside from the pumps has been supplied by means of fire extinguishers placed at intervals throughout the ship. These extinguishers are made by the Pyrene Manufacturing Company of New York.

The "Semmiltind" is 260 feet long O. A., has a width of 46 feet and a moulded depth of 26 feet 5 inches. Her deadweight tonnage is 3,350, and the actual carrying capacity is estimated as being 200 tons more than a steamship of similar dimensions.

PROGRESS IN NORWAY

There have been recently launched in Norway many typical motor-coasters of small tonnage and of a type that has proven immensely lucrative in the trades between the Scandinavian countries and Great Britain.

The "Rutha," of 450 tons of d.w.c. was built at Grunstad, No. 135 of 600 tons at Bolsones, and the "Ellen" of 500 tons d.w.c. with another of 800 tons d.w.c. and the "Sofus Magdelon" of 600 tons have been completed and launched at Haugesund. Several concrete motor-vessels have also been launched recently. Norwegians seem to be very favorably disposed toward the concrete motor coaster and it is hard to believe they would indorse such a scheme without pretty reliable and acceptable proof of its worth.

The cargo motor-vessel "Lardel" recently ran her trials. She was built for the Lardel Shipping Co. of Larvick and is powered with a 220 h.p. four-cylinder Grei oil-engine. She is 153 ft. 9 in. long, 26 ft. 3 in. beam and has a d.w.c. of 650 tons.

RECENT ADDITIONS TO THE PACIFIC MOTORSHIP FLEET

Two wooden motorships have been designed and built by the Columbia Engineering Works at Portland, Ore. They are the "Mildred" and the "Avance," illustrated herewith. Both are about ready for their trial trips.

The "Mildred" is 180 ft. long, 36 ft. beam, rigged as a four-masted schooner and equipped with auxiliary power, developed in twin "Skandia" engines of 120 b.b.p. each. The Mildred Motorship Corp. of New York, which owns both vessels, will probably place them in the South Pacific or Gulf Trade.

The illustrations show that the "Mildred" has her engines well aft, giving accommodations for lengthy cargoes, such as lumber, rails, bar iron,

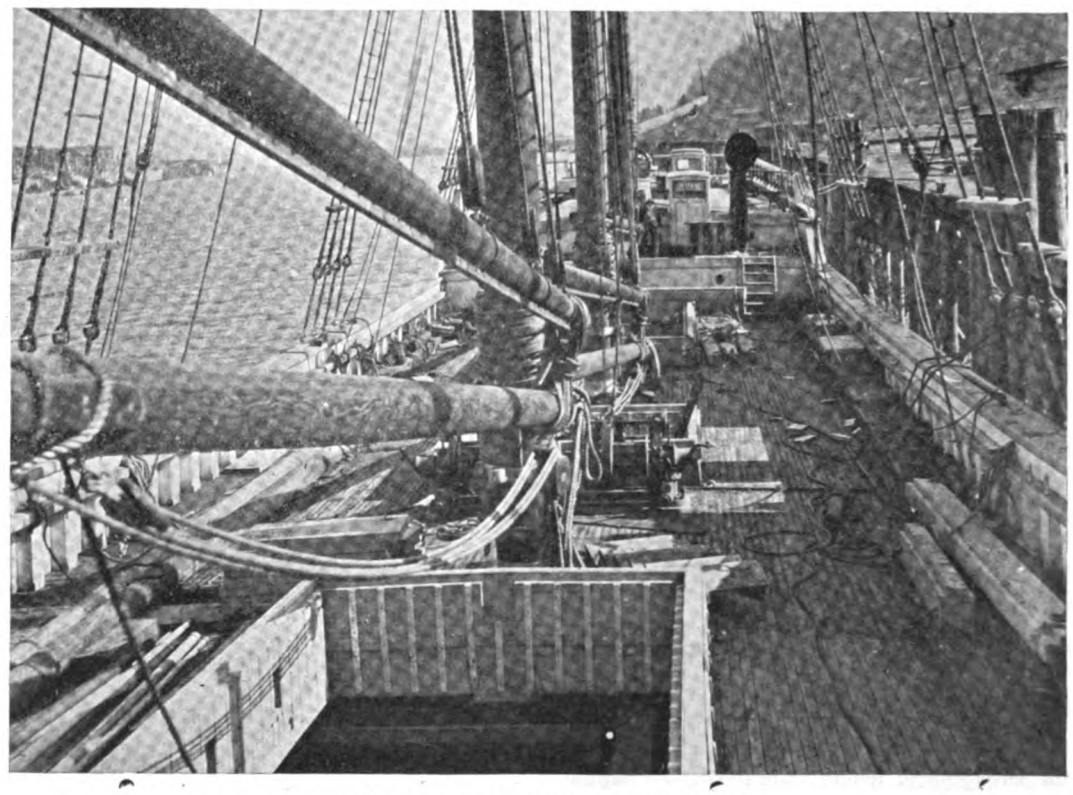
The Auxiliary "Avance"

etc. Even with miscellaneous or bulk cargoes, long unobstructed holds assist materially in loading and unloading.

A different design is embodied in the construction of the "Avance." Her dimensions are, length, 168 feet; breadth, 30 ft. High top sides in way of the after hold result in a long flush deck extending from the forward bridge-end bulkhead to the poop. This arrangement provides exceptional space in the 'tween-decks aft, giving stowage volume especially valuable in transporting cargo which must be well protected. She was originally designed to transport ice from Norway to Great Britain, which accounts for the unusual appearance. A surface-ignition 320 b.h.p. "Avance" heavy-oil motor built by Svenson's Motorfabrik is installed amidships.

Both these vessels have capacities for a generous amount of fuel, thus making them independent of any but the most reasonable fuel prices within a wide cruising radius.

The 234 net-tons steel motorship "Dalaskar" has been completed by the Bergkvarn Skappsvaw of Dalaskar, Sweden. A 240 b. h. p. Bolinder oil-engine is installed, giving a speed of 8 knots.



Looking Aft on the Deck of the "Mildred"

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Trials of New American Auxiliary Schooner

The Delaware-Built, Winton Diesel-Powered Vessel "Chas. S. Gawthrop" Averages 9.12 Knots on Tests—Sister Ship Has No Propelling Power

By GEO. A. COLLEY

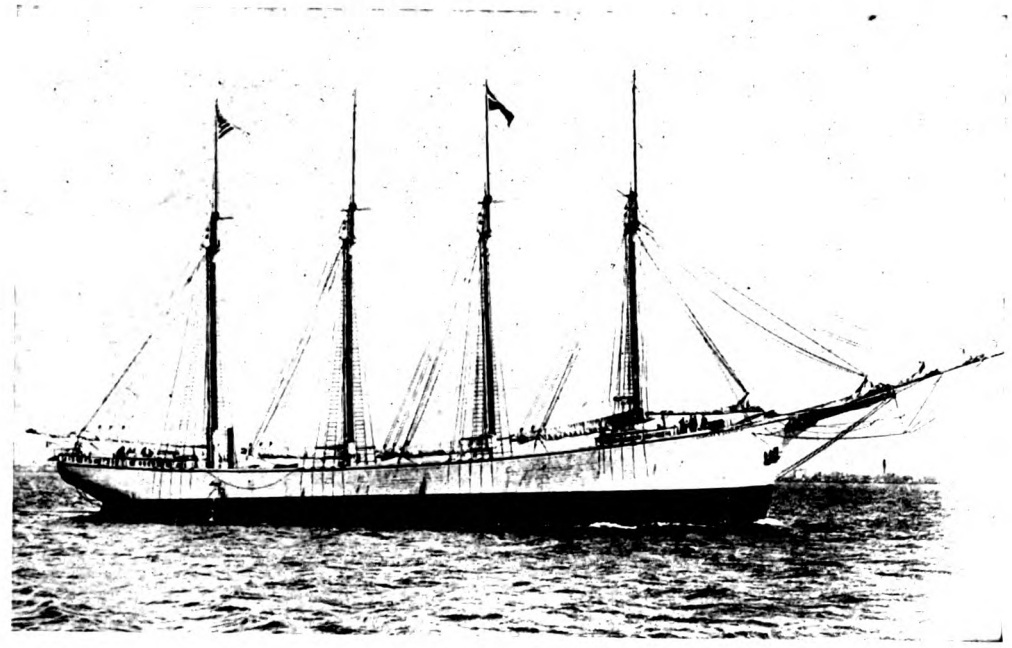
THAT the poor results of some of the under-powered, auxiliary sailing-ships in service have not turned all shipowners against this class of vessel is indicated by the launches and trial trips which frequently occur in various parts of the U. S. Coasts. The Woodin Transportation Co. of Wilmington, Del., have recently taken delivery of the Diesel-engined auxiliary-schooner "Charles S. Gawthrop", built by the Jackson & Sharp plant of the American Car & Foundry Company, Wilmington, Delaware, engined by the Winton Engine Works of Cleveland, Ohio, and designed by Tams, Lemoine & Crane of New York, which vessel had a very successful trial run from Wilmington to Delaware Breakwater, on Thursday, November 13, 1919.

The performance on trial was satisfactory in every way and it will be exceedingly interesting to compare the performance of the "Chas. S. Gawthrop" with her sister ship the "W. H. Woodin", which is an out-and-out sailing-schooner. The "Woodin" has a dead-weight capacity of 2220 tons, while the "Gawthrop" capacity is 1960 tons at the same draft, a decrease of 11.7 per cent. These two ships should give a very good opportunity to ascertain the relative earning-capacities of the two types of ship.

The general dimensions and specifications of this vessel are as follows:

Length overall	230′ 0″
Length (B.P.)	210′ 0″
Moulded Beam	39′ 0″
Moulded Depth	24′ 10″
Gross Tonnage	1488
Net Tonnage	1227
D. W. Capacity	1960 tons
Draft	23′ 5″
Fuel-Capacity	30,000 gal.
Radius under power (about)	7,000 nautical-miles

As shown in the accompanying illustrations, she is a typical four-masted schooner and is powered with two 6-cylinder 12 15-16 by 18 in. Winton Diesel motors. Particular attention was paid to the machinery installation. All outboard work, such as struts, wheels, etc., are of bronze. The struts, propellers, stern bearings and stuffing boxes were furnished by the American Manganese Bronze Co. All tanks are set in drip-pans scuppered to a common sump-pit with pump connection, and the engine-beds were metal sheathed throughout.



The Diesel-engined auxiliary schooner "Chas. S. Gawthrop," which ran her trials on the Delaware on November 13, 1919

Dock trials had been held during the previous week and all air, steam, and oil lines had been tested out as well as the electric-lighting plant and all other auxiliaries. The schooner left the American Car & Foundry Co.'s dock on the Christiana River at ten minutes after two Thursday, November 13th, with tow-boat alongside. Previous to leaving the dock, the engines had been warmed up and everything was in satisfactory working condition. The tide was running in and had about three hours to come. No difficulty was found in maneuvering around the sharp turns and at 2:35 the tow-boat was dropped at the mouth of the river.

The engine-speed was increased from 175 turns to 204 turns on the port engine and 200 on the starboard engine. This was gradually worked up further inside the next fifteen minutes, to 208 turns on the port and 210 on the starboard.

At 3:04 P. M. the engines were running port 214, starboard 216. Arrived abeam Ship John Light at 6:13, with everything running smoothly and revolutions 213 on both engines. Slowed down at this time to allow steamship to pass in channel, as she had slightly more speed.

At 6:35 went full speed ahead again and arrived abeam Miah Maul Shoals at 7:25. At 8:05 the engines were slowed down to half speed on account of a ship maneuvering for anchorage being in our way. At full speed again at 8:08, the engines now running 213 port and 214 starboard. In the next hour the engine speed was increased to 218 turns port and 219 starboard. Arrived at the entrance to the Delaware Breakwater at 9:40 and dropped anchor at 9:45.

During the entire trip readings were taken on both engines for revolutions, air-pressures, fuel and lubricating-oil pressures and temperatures of discharged-water. The discharge-water temperature was very low, averaging 70 degrees throughout. During the whole trip the engines ran without any trouble of any sort whatsoever, maneuvered perfectly and ran cool throughout. The various auxiliaries also ran perfectly.

In checking up the various observations made on the trial, the following results were obtained:

Time from mouth of Christiana River to Delaware Breakwater, 7 hours, 10 minutes.

Distance, 65⅜ nautical-miles.

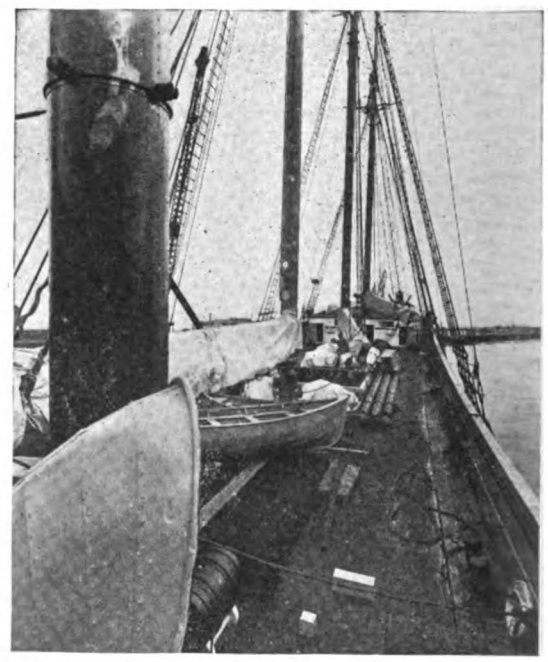
Average revolutions, 214 turns per minute.

Average speed, 9.12 knots.

The fuel-consumption was at an average rate of 30 gallons per hour, but from later advices from the ship on the trip to Key West, this consumption was reduced to about 28 gallons per hour. The lubricating-oil consumption was at the rate of 10 gallons per day for both motors. On the run light to Key West the motors gave the same uniform satisfaction as was given on the trial trip, the average speed from Breakwater to Sand Key being about 8 knots.

All auxiliaries with the exception of the two generators, two electric-driven blowers, the Kewanee water system and a horizontal duplex 5 H.P. 3¾ in. x 4 in. general-service pump are steam-driven from the donkey boiler in the forecastle head.

The steam auxiliaries consist of the usual windlass and capstan forward, six single drum winches, one boiler-feed pump, one 6 in x 8½ in. x 6 in. horizontal duplex bilge-pump, one 5¼ in. x 4¾ in. x 5 in. horizontal duplex fire, bilge, and general-service pump, one 5¼ in. x 4¾ in. x 5 in. h.d. oil-transfer pump; one 3 in. x 2 in. x 3 in. h.d. condensate pump; one Wheeler condenser of 350 square feet of cooling surface with direct connected combined air and circulating pump 6 in. x 8 in. x 8 in. x 10 in. discharging to the hot well aft, and one steam driven air compressor for starting and maneuvering.



Deck of the "Chas. S. Gawthrop" looking forward

The electric-light plant consist of one 10 H.P. Fairbanks-Morse kerosene engine set, direct connected to a 6 K.W. generator, and a 5 K.W. auxiliary generator driven by a silent-chain and clutch from the port motor tail-shaft. These two generators are supplemented by a 75 ampere hour Edison storage battery. The entire electric installation is of the highest grade.

Both steam and electric-driven general-service pumps are connected to the main engine circulating line and can also be used to supply circulating water for the auxiliary air-compressor.

Both main and auxiliary machinery spaces are well ventilated and very comfortable, although the installation is very compact. There is a space about ten feet long directly aft of each main engine on the 'tween deck and directly under the end of the engine lifting-gear, which gives ample space for handling repairs. The handling-gear will lift and transfer parts weighing up to three tons. A small power-lathe and forge are among the engineer's equipment, and everything has been done to make the equipment complete in every way.

RECORD SHIP LAUNCHING

On Dec., 1919, six large steel freighters were launched at the yard of the Moore Shipbuilding Co., Oakland, Calif. This is the world's record. They were of 10,000 tons d.w.c. and 9,400 tons d.w.c.

AUXILIARY SCHOONER WITH PRODUCER-GAS MACHINERY

The four-masted schooner "Bessie A", 594 tons net, recently arrived at Waterford, Ireland, from Alma, N. B., Canada, where she was built. She is fitted with a 200 h.p. Wolverine electric-ignition type internal-combustion engine operating on producer-gas.

THE MOTORSHIP "ISONZO"

In our last issue we stated that the Sulzer Diesel-engines of the "Isonzo" were built at the Savoia Company's plant. We, however, are advised that these particular engines were built at the Sulzer works in Winterthur, and were shipped to the Savoia Yard, where they were installed.

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"Motorship" Illustrated Patent Record*

Selected Abstracts of Recent Published Patents of Internal-Combustion Engines

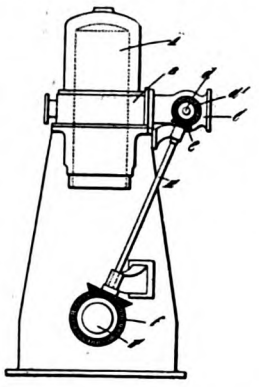
Copies of original specifications may be obtained for ten cents each, by addressing the "Commissioner of Patents, Washington, D. C."

*Compiled and described by H. Schreck, Consulting Diesel Engineer

1,318,781. Oct. 14, 1919. Two-stroke Cycle Engine. J. McKechnie, of Barrow-in-Furness. Assignor to Vickers, of Westminster, England.

This invention refers to novel arrangements in the scavenging to two-stroke cycle engines of the port scavenging type and has as its object to reduce the consumption of scavenging air, thereby increasing the efficiency of the engine and a further increase of the latter is obtained by increasing the initial pressure of the scavenging air in the working cylinder.

For this purpose close to each cylinder an exhaust controlling valve is arranged which is so actuated as to give full exhaust opening but closing to check or throttle the escaping gases before the closing of the exhaust ports by the piston takes place. In engines of said kind a considerable loss of scavenging air takes place through the open exhaust ports after the exhaust gases have been wiped out, thus decreasing the pressure of the scavenging air in the cylinder. The arrangement of the inventor, however, will control the exhaust by said valve and keep a larger portion of the scavenging air in the cylinder. Increased compression is thus obtained or less compression of the scavenging pumps will be required, both of which will increase the power of the engine. The valve itself may be a rotary valve or a spring loaded throttle valve operated by a cam or other means.



1,320,062. Oct. 28, 1919. Two-stroke Cycle Engine. H. Junkers of Aachen, Germany. Assignor to L. M. Wheelock, of Boston, Mass.

This invention refers to an arrangement on a two-stroke cycle engine of the port scavenging type with the object to increase the output of the engine temporarily, such as is desired on locomotives, hauling engines and the like, or for a time of temporary or continuous overload.

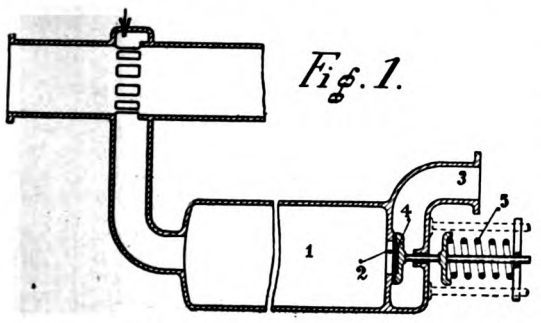


Fig. 1.

In the illustration the cylinder is charged with fresh air at 6 and the exhaust gases leave at the opposite side escaping into the exhaust receiver 1. This receiver provided with a spring loaded or in any other way controlled outlet valve 2 will maintain a back pressure at a predetermined point, this substantially constant pressure being determined upon by reference to the amount of increase in the output of the engine desired. It is obvious that the back pressure of this receiver will regulate the pressure of the charge of scavenging air in the cylinder, at the beginning of the compression stroke and more or less according to its pressure increase the output of the engine.

It will be noticed that the invention No. 1,318,781 of Mr. J. McKechnie, reported on in this paper, has the same object as this patent.

1,320,063. Oct. 28, 1919. Valve Gear for Injection Valves. H. Junkers, of Aachen, Germany. Assignor to L. M. Wheelock, of Boston, Mass.

This invention relates to the control of the length of time during which the fuel is admitted into the cylinder. The purpose of the invention is to vary the time during which the valve is lifted from its seat without changing to a substantial degree the point at which the valve is opened relatively to the position of the piston. The object of this invention is to reduce the consumption of compressed air when the engine is running slowly or at reduced load, and to avoid the disadvantages resulting therefrom.

Fig. 2.

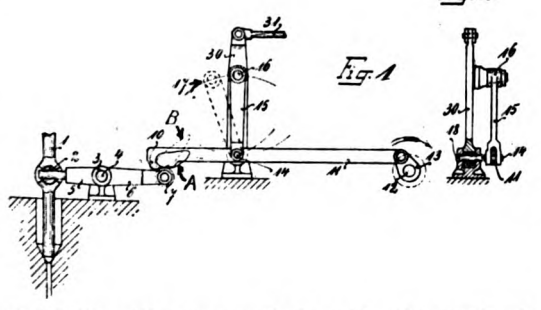


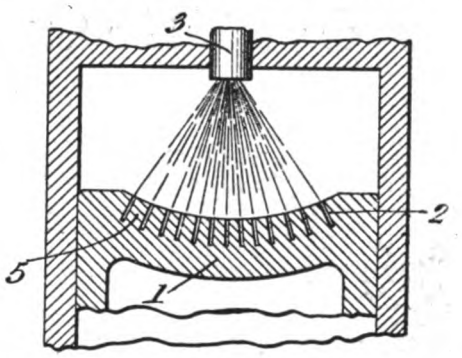
Fig. 1

In the illustration numeral 1 designates the valve needle which is operated by a rocking lever 9. The roller 7 as shown at the end of this lever is engaged by cam 10 on one end of a rocking lever 11, which is pivotally connected to an eccentric 13 on the camshaft 12. The lever 11 is rocked about the pivot 14 at the end of link 15 by which the lever is supported. The rotation of the camshaft causes lengthwise reciprocation of the lever 11 and as a result of this a point of the cam 10 will move through the curve A and lift the valve. If, now, lever 15 is moved over, either by hand or through a connection to a governor into the dotted position 17, the above said point of the cam will move through the dotted curve B. The path of this curve indicates clearly that the opening of the valve will occur at the same point in the rotation of the eccentric 13, but relieve the operating lever of the injection valve considerably quicker.

1,320,064. Oct. 28, 1919. Piston. Hugo Junkers, of Aachen, Germany. Assignor to L. M. Wheelock, of Boston, Mass.

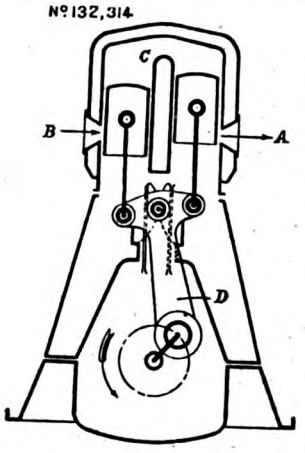
This invention refers to a new construction for pistons of internal-combustion engines. The object of this invention is to construct a piston-head which can freely expand with the changes of temperature and whereby the carrying away of heat by the piston can be greatly reduced.

To obtain said purpose the piston-head is provided with a number of narrow grooves distributed over the top of the piston. Owing to the relatively small width and great depth of the grooves they become filled with the residues of combustion when the engine is working, which residues exercise an insulating action, without preventing expansion. If desired, the grooves may be enlarged toward the interior of the piston so that the residues of combustion are prevented from falling out of them. Instead of using the residues as insulation, the grooves may be provided from the first with an insulating material or the insulating material may be cast into the grooves.



132,314. Aug. 12, 1918. Two-stroke Cycle Engine. A. Franco, of Turin, Italy (British Patent).

This patent refers to two-stroke cycle internal combustion engines of the kind comprising two parallel cylinders communicating with each other so as to form a common combustion chamber, the two pistons being phase displaced are connected to the ends of the transverse limb of a T-shaped connecting rod.



There are only two ports provided, that is, port B for inlet and A for exhaust. Toward the end of the power strike the right-hand piston opens the exhaust port A, while the other piston still covers the inlet port B and vice versa on the compression stroke the port A closes before the port B is closed so that through the latter port the charge of air or gas can be supplied.

The magnitude of the phase displacement of the two pistons is determined by the ratio between the length of the rod D and the crank. It is sufficient to reverse the course of the gases in order to reverse the direction of rotation of the engine.

In order to have our record complete, although it may not be of direct interest to the oil-engineer, the three following patents may be listed:

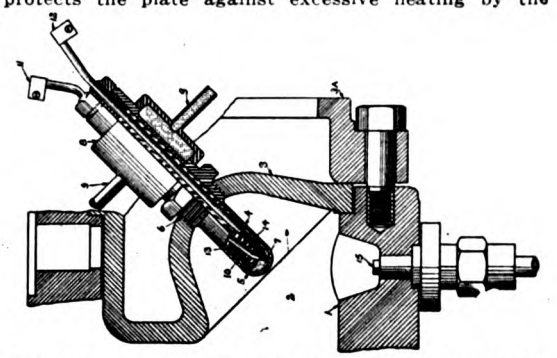
1,317,899 and 900. Oct. 7, 1919. Hot Plate Apparatus. H. F. Shepherd. Assignor to Bessemer Gas Engine Co., both of Grove City, Pa.

This invention refers to a novel ignition device on hot bulb engines.

In the illustration numeral 1 designates the cylinder, 2 the explosion chamber, 3 the hot bulb, 3a a ring for securing the hot bulb in place and 4 a starting plug.

The starting plug comprises a hot plate in the form of a receptacle 5, which contains a liquid having a predetermined desired vaporizing point Ordinarily mercury is used, this having a vaporizing point approximately that desired. A water jacket surrounds the outer end of the plug and is connected to the circulating system of the engine. This water jacket serves as a condenser so that any vapor arising from the heated liquid is immediately condensed and as a liquid returned to the lower receptacle. The temperature of the plate from its direct contact with the liquid is maintained approximately constant at the vaporizing point of the liquid.

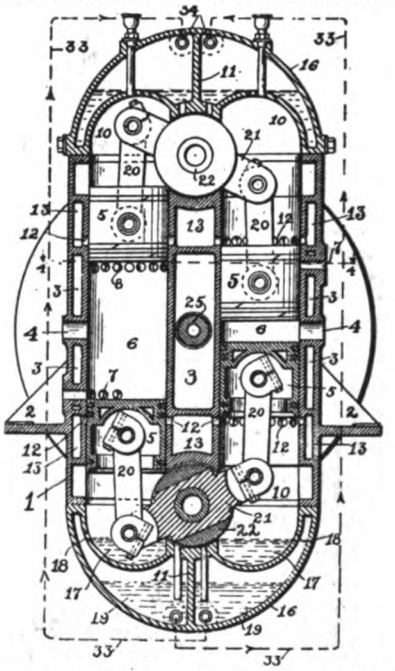
In order to heat the plug for starting the engine an electric heating coil 14 is immersed in the liquid. The liquid not only maintains the plate below a temperature at which it can be injured through the excessive heat caused by the explosions of the engine, but it also protects the plate against excessive heating by the electric heating element. The plug proper is preferably arranged directly opposite the fuel injection nozzle 15.



1,317,939. Oct. 7, 1919. Internal Combustion Engine. C. J. H. Penning, of New York, N. Y.

This patent refers to a new arrangement of oil or any explosive engine, preferably of the two-cycle type. The cylinders are arranged in pairs and each cylinder has two pistons between which the explosion occurs. The movement of the pistons is transmitted to a single crank by means of rockers and connecting rods.

In the accompanying illustration numeral 4 designates the connection for a fuel valve or gas inlet, 7 at one end of the cylinder are the exhaust ports, and 8 at the other end the inlet ports, which open into a communication passage which runs in back of the cylinder from end to end of the cylinders to the pumping spaces 10. Each piston is connected by a rod 20 with a rocker arm 21 mounted on a rock shaft 22 and cranks arranged at the end of these shafts are each connected by a connecting rod to a common end crank of the crank shaft 25.



HUGE FOUNDRY FOR FAIRBANKS-MORSE COMPANY

During the early part of this year a very large foundry will be constructed at Beloit, as an extension to the works of the Fairbanks-Morse Motor Company. It will have a daily capacity of 350 to 400 tons, and will cost approximately $1,500,000.00. Furthermore, it will mean direct employment of 1500 men, and the increased production that will result will mean another 1500 men being employed in other departments. It will equal in size and output any foundry in the world, and will be the most modern in existence. Its length will be 900 ft. by width 550 ft., and will contain 490,000 sq. ft. of floor space, covering 11 acres of ground. A very complete electrical equipment will be installed throughout, and when the foundry is completed it is our intention to publish photographs and complete details.

We may mention that the Fairbanks-Morse Company are builders of a surface-ignition type marine heavy-oil engine which has been very largely adopted on auxiliary motor-vessels and moderate sized commercial craft, including trawlers and other fishing-vessels, also in hundreds of small work-boats.

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